Fall 12-21-2018

Factors Associated with Adults' Perceptions of Nicotine and Nicotine e-Liquid Harm to Young Children and Associations with Nicotine Handling Behaviors in the Home

Catherine Blanchard Kemp
Georgia State University

FACTORS ASSOCIATED WITH ADULTS' PERCEPTIONS OF NICOTINE AND NICOTINE E-LIQUID HARM TO YOUNG CHILDREN AND ASSOCIATIONS WITH NICOTINE HANDLING BEHAVIORS IN THE HOME

by

CATHERINE BLANCHARD KEMP

B.S.N., WORCESTER STATE UNIVERSITY
M.H.A., WORCESTER STATE UNIVERSITY

A Dissertation Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
Requirements for the Degree

DOCTOR OF PHILOSOPHY IN PUBLIC HEALTH

ATLANTA, GEORGIA
30303

Copyright Application has been submitted to the United States Patent Office.

ABSTRACT

FACTORS ASSOCIATED WITH ADULTS' PERCEPTIONS OF NICOTINE AND NICOTINE E-LIQUID HARM TO YOUNG CHILDREN AND ASSOCIATIONS WITH NICOTINE HANDLING BEHAVIORS IN THE HOME

By

CATHERINE BLANCHARD KEMP

JULY 31, 2018

Electronic nicotine delivery systems (ENDS) use has grown rapidly over the past decade. ENDS-specific harms have emerged among children (particularly those ≤ 6 years), related to exposures to nicotine e-liquids (NEL) used in ENDS. Children have been identified as a priority population in terms of the potential and actual NEL-caused harm in the United States (US). Evidence is lacking examining contextual factors such as adults' risk perceptions related to child NEL exposures and how these materials are handled in homes where children are present. Guided by the Protection Motivation Theory (PMT), this dissertation focuses on adults' risk perceptions of children's exposure to nicotine and NEL handling practices in the home.

Study 1 examined risk perceptions related to children's (< 13 years) exposure to nicotine generally (not product-specific) among a representative sample of US adults, and found that current tobacco product users, males, and persons from racial/ethnic minority backgrounds were significantly less likely to perceive nicotine as harmful to children. Study 2 examined risk perceptions related to children's (≤ 6 years) exposure to NEL in two dose-levels by five exposure modes, among adults who lived with at least one child (≤ 6 years) and were ENDS users, non-users living with a user, or never-users in never using homes. Study 2 found that ENDS-users were significantly less likely (versus never users from never-user homes) to perceive NEL exposure as moderately or very dangerous in 7/10 of dose/mode dyads examined. Study 3 examined relationships between perceptions of NEL-related risk to children and NEL handling practices among adult ENDS-users and non-users living in ENDS using homes who also had a child (≤ 6 years). This study found that being a non-user was significantly associated with not knowing about the NEL handling practices in their home, and perceiving child NEL exposure as very dangerous was significantly associated with always using childproof caps.

These findings highlight the need to educate adults about nicotine's harmfulness to children and to develop measures to protect children from nicotine and NEL exposures. Opportunities to improve all adults' NEL-related knowledge to improve safety for children are also discussed.

ACKNOWLEDGEMENTS

The research presented in this dissertation was supported by grant number P50DA036128 from the NIH/NIDA and FDA Center for Tobacco Products (CTP) and by grant number K23AT008442 from the NIH/NCCIH. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the FDA.

Ms. Kemp expresses her appreciation to Terry F. Pechacek, Ph.D, Claire A. Spears, Ph.D, David L. Ashley, Ph.D, Michael P. Eriksen, Sc.D., Scott L. Weaver, Ph.D, Pamela B. Redmon, MPH, and Rachel Lawley, MPH at the Georgia State University Tobacco Center of Regulatory Science for their mentorship, support, and encouragement in developing the research presented in this dissertation.

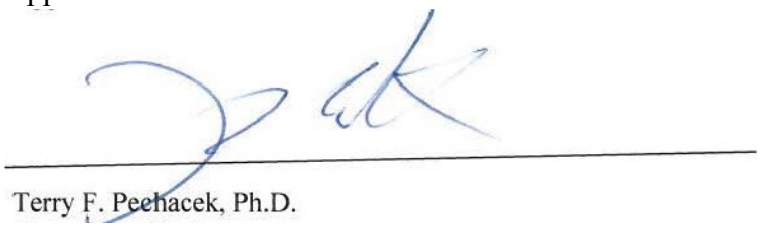
APPROVAL PAGE

FACTORS ASSOCIATED WITH ADULTS' PERCEPTIONS OF NICOTINE AND NICOTINE ELIQUID HARM TO YOUNG CHILDREN AND ASSOCIATIONS WITH NICOTINE HANDLING
BEHAVIORS IN THE HOME

by

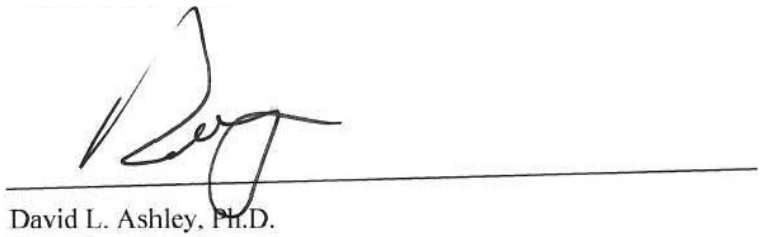
CATHERINE BLANCHARD KEMP

Approved:



Terry F. Pechacek, Ph.D.
Committee Chair

Claire A. Spears, Ph.D.
Committee Member



David L. Ashley, Ph.D.
Committee Member

July 31, 2018
Date

Author's Statement Page

In presenting this dissertation as a partial fulfillment of the requirements for an advanced degree from Georgia State University, I agree that the Library of the University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote from, to copy from, or to publish this dissertation may be granted by the author or, in his/her absence, by the professor under whose direction it was written, or in his/her absence, by the Associate Dean, School of Public Health. Such quoting, copying, or publishing must be solely for scholarly purposes and will not involve potential financial gain. It is understood that any copying from or publication of this dissertation which involves potential financial gain will not be allowed without written permission of the author.

Catherine Blanchard Kemp (Author)

7/31/2018

Contents

Chapter 1:
Introduction and Statement of Purpose

Introduction

Patterns of tobacco product consumption in the United States (US) have been changing dramatically in recent years.[1] For example, from 2000 to 2015 while consumption of non-cigarette combustible tobacco (e.g., cigars and pipe tobacco) increased by 117.1% and use of smokeless tobacco products (snuff and chewing tobacco) increased by 23.1%, Americans' total consumption of cigarettes declined by 38.7%.[1] In addition, use of electronic nicotine delivery systems (ENDS; e.g., e-cigarettes) among both adult[1-4] and adolescent [5-9] populations has steadily increased since these products were first marketed in the U.S. in 2007.[2,3] More than a fifth of American adults have used ENDS to consume vaporized nicotine,[4] and most ENDS users also smoke combustible cigarettes (commonly referred to as dual use).[4,10-12]

Among Americans who have ever smoked cigarettes, 38.2% of current smokers and 49.3% of recently former smokers have used ENDS.[13] While use of ENDS has grown steadily among all age groups in the U.S. in recent years, it has grown more rapidly among adults 18-44 years.[14,15] Furthermore, research indicates that 40% of American ENDS users aged 18-24 years had never smoked cigarettes.[16] It is unclear whether or how never-smoker ENDS users' knowledge and risk perceptions of nicotine might differ from that of smokers who may have more experience using nicotine products.

ENDS are devices in which battery-powered heating coils aerosolize liquids containing propylene glycol or vegetable glycerin as the suspending agent along with food-grade flavorings and varying amounts of nicotine[17-19] for inhalation. The two most commonly used ENDS are e-cigarettes (prefilled, sealed, disposable units)[19,20] and refillable vaporizers[20-25] ("vapes"; open systems with refillable tanks or replaceable cartridges that are the reservoirs for the e-liquid[19,20,26]). The range of ENDS products is constantly evolving with increasing diversity and

technological sophistication.[27] Over this rapid evolution unanticipated consequences have emerged, such as nicotine toxicity among children resulting from exposures (by ingestion and dermal contact) to the flavored e-liquids. Data from the GSU TCORS annual Tobacco Product Use and Risk Perception Survey indicate that in 2016, slightly more than a third of U.S. adults who had ever used ENDS (34.6%; 95% CI: 30.9% - 38.2%) and of current ENDS users (36.0%; 95% CI: 30.0% - 42.0%) had at least one minor child living in their home (unpublished analysis performed by CBK).

Current evidence indicates that ENDS-use is most likely safer than smoking combustible cigarettes[28-33]; this should not be construed that ENDS are *harmless*.[34] The nicotine e-liquids (NEL) used in ENDS are described by proponents of vaping as "safe" because they contain widely-used ingredients such as propylene glycol and food-grade flavorings.[35] Despite growing enthusiasm for the potential of ENDS as smoking cessation tools,[36] more research is needed to evaluate the validity of such claims.[37-46] This enthusiasm, coupled with the tendency to view potential ENDS-associated harms in relation to the harms of combustible tobacco use, has contributed to under-recognition of and inaccurate perceptions of ENDS-specific harms such as nicotine toxicity from ingestion or transdermal/mucosal exposure to nicotine e-liquids, particularly among children.[29,30] The need for knowledge regarding child exposure to nicotine contained in novel tobacco products and how the availability of these products affect non-smoking populations has been discussed by clinical,[29,30] ethical,[47] and regulatory policy[48] scholars.

Exposure to NEL (by ingestion and dermal absorption) has resulted in a variety of clinical consequences in the U.S., ranging from acute gastro-intestinal illness with full recovery to death.[49-52] Nicotine concentrations in NEL vary widely. Laboratory studies have found wide

variance between labeled and actual levels,[53,54] making it difficult to determine ingested doses accurately. Nicotine exposure during fetal, infant, and childhood development has been associated with a range of neuro-cognitive and developmental disorders.[55]

Oral nicotine doses of 10 mg. in children and 30-60 mg. in adults are considered lethal.[56] NEL are typically sold in 15 ml bottles; with the recommended nicotine concentrations of 6 mg/ml (0.6%) for light to intermediate smokers, [57,58] the amount of nicotine contained in one 15 ml bottle of NEL could be a fatal to an adult or a child.[29,56] However, in a recent review of the supporting evidence for these estimated lethal doses, Mayer points out that these estimates may be dubious and actual cases of lethal nicotine ingestion are rare.[59] Despite questions regarding nicotine's actual lethal oral dose, there is growing evidence in the literature of acute severe illness associated with ingestion of nicotine NEL by children.[30,50,51,60-66] In addition, neurodevelopmental, metabolic, and cognitive disorders emerging during childhood and adolescence have been associated with nicotine exposure during fetal[30,62,67-79] and early childhood[30,75-77,80] development.

Research regarding risk perceptions about nicotine has generally focused on its addictiveness, with some recognition that nicotine exposure may be harmful to developing fetuses.[28,81,82] Furthermore, studies have generally focused on inhaled nicotine from second- or third-hand (nicotine accumulation on surfaces in environments where smoking has taken place) exposure. This lack of recognition of potential harms of nicotine to children may have contributed to the almost 15-fold increase in calls to the National Poison Data System between 2012 and 2015 regarding childhood nicotine NEL exposures.[50] Of particular concern, children ingesting nicotine NEL have been shown to have a more than five times greater likelihood of receiving inpatient treatment and more than double the likelihood to have a severe outcome,

compared to those who ingest materials in traditional cigarettes.[50] One death of a child resulting from nicotine ingestion was documented in the U.S. between January 2012 and April 2015.[50]

Concerns over NEL-related childhood nicotine exposures resulted in Congress approving the Child Nicotine Poisoning Prevention Law[83] (CNPP) which became effective in July 2016 and mandates childproof packaging of nicotine-containing e-liquids. The CNPP gives authority to the Consumer Product Safety Commission (CPSC) to test whether the packaging is childproof under CPSC's existing guidelines.[84] The test involves a two-step procedure in which children, aged 42-51 months, are given two sequential opportunities of 5 minutes each to open a "childproof" container after all tamper-resistant packaging has been removed.[85] I have been unable to find any information regarding enforcement and/or compliance with the CPSC regulations in relation to nicotine e-liquids.

The 'deeming rule' refers to a set of regulatory actions taken by the U.S. Food and Drug Administration (FDA) in 2016 in which the agency asserted its tobacco regulatory authorities to non-cigarette tobacco products such as ENDS and NEL.[86] Enforcement deadlines for ENDS product regulations under the deeming rule were extended in late 2017, to as far as August 2022, although none are specific to child-resistant packaging.[87]

Although there was an approximately 20% reduction in the number of NEL exposures reported monthly in the year following CNPP's enactment, several hundred such exposures continue to be reported monthly in the US.[88,89] There are published and proposed regulations under the deeming rule[90] that will address some aspects of nicotine-containing NEL safety; however, many of these will not go into effect for several years[87] and they do not specifically target issues related to children being exposed to nicotine e-liquids. For example, the requirement for health warning labels to be applied to nicotine-containing bottles and other

vessels requires the label to state: 'WARNING: This product contains nicotine. Nicotine is an addictive chemical''[90] (p.7). There is currently no provision mandating any warning pertaining to the toxicity of nicotine when ingested or absorbed through the skin or mucous membranes, nor its particular toxicity to children.[90] This underlines the need for better understanding of childhood nicotine exposure-related risk perceptions held by tobacco product users and adults who live with them and the need for interventions to educate them on the dangers of childhood nicotine exposure and how to prevent it.

NEL typically contain food-grade flavorings that can be tasted when in contact with taste buds; many of these flavors are appealing to children (e.g., fruit and candy flavors).[8,91] I have not found any published research describing factors related to the packaging of flavored NEL that might be especially appealing to young children (6 years old and younger), or effectiveness of mandated child-resistant packaging. There is evidence from research involving adolescents indicating that visual depictions of NEL flavorings are associated with increased interest in trying ENDS.[92,93]

One published study[94] examined parents' risk perceptions and risk factors of exposure of children to NEL in the home environment. A convenience sample of parents ($N = 658$) bringing children to scheduled appointments at a multisite pediatric practice in St. Louis, Missouri were surveyed over a two-month period in 2015. That study found that while almost three-quarters (74%) of the 73 parents who reported e-cigarette use in the home felt it would be "very dangerous" if their child swallowed the e-liquid, 36% neither stored the NEL in locked spaces nor used child-proof caps, 19.7% only used child-proof caps, 8.2% reported only locking up the e-liquids, and 31.1% reported that they both used child-proof caps and stored the bottles in a locked space. These findings offer important insights, but the generalizability may be limited due

to the relatively small sample size and restricted sampling frame, and they have yet to be replicated (to my knowledge).

Statement of Purpose

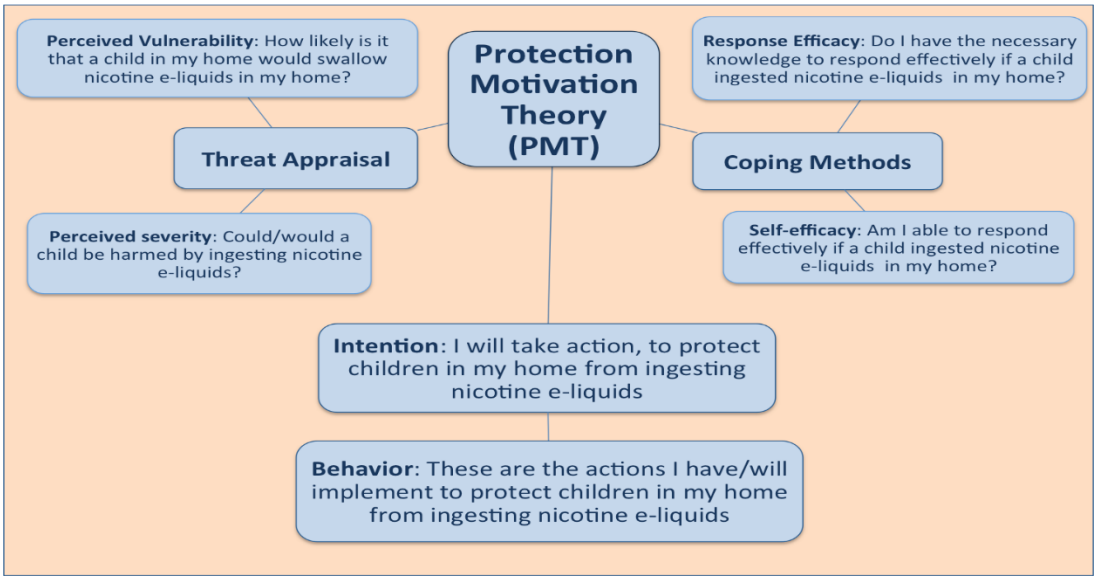
Regardless of whether ENDS are effective as smoking cessation aids or how they are marketed, it is important to communicate that these products are not free of risks[50,51,60,63,64,66,95] and to provide evidence-based guidance on appropriate precautions. Effective mitigation to reduce the risks of exposure to children in households where ENDS products are used will require a multifaceted approach involving several different target populations (including adults in the general population, adults who use ENDS products and have children in their homes, and adults who live in homes where another person uses ENDS products and child(ren) also live). The first step in this mitigation process will be to assess the knowledge and risk perceptions related to childhood nicotine exposures held by each of the target populations to inform the development of future mitigation interventions and policies.[96,97]

Such a multifaceted approach to reducing the risk of children being exposed to nicotine from novel tobacco products such as ENDS will (hopefully) result in more effective and efficient targeted interventions. It will support the goal of reducing one of the identified principle sources of ENDS-related harm to this at-risk priority population[34] by improving safe NEL handling broadly, and specifically in homes where ENDS products are used.

The research presented in this dissertation was theoretically informed by the Protection Motivation Theory (PMT),[98,99] a framework which proposes that a person's coping with a health threat is informed by two processes: their assessment of the threat and assessment of the options available to them to cope with the threat.[98-103] Development of the survey instrument used in Study 2 and Study 3 was guided by the PMT constructs of perceived vulnerability and perceived severity of the threat appraisal process and the response efficacy and self-efficacy of the coping

methods process,[101,103] as illustrated in Figure 1. PMT was developed by Rogers[98] to provide a framework for conceptualizing fear appeals. This conceptual framework is well-suited for research related to caregiver behaviors to protect children from harm; PMT has been used in previous research to model home safety of small children[104] and injury prevention among children working on family farms.[105] In these studies,[104,105] protection motivation was hypothesized to be invoked when parents perceive their child to be under threat of injury. In a similar fashion, the perceived threat of harm to the child from NEL exposures was assessed in Study 2. The relationship between this perceived threat of NEL exposure-related harm to the child invoking the adult's protective behavior to prevent NEL exposures to the child was modeled in Study 3.

Figure 1. Graphic depiction of Protection Motivation Theory (PMT) applied to the context of the research presented in this dissertation.



Chapters 2, 3, and 4 of this dissertation document present the dissertation research performed in manuscript format. Study 1, presented in Chapter 2, examines adults' risk perceptions of children (<13 years) being exposed to nicotine in general (not by specific product type), stratified by current tobacco product use and controlling for demographic characteristics in

a large, nationally representative sample. Study 2 examines adults' risk perceptions of specific doses and modes of NEL exposure to children aged six years and under in relation to current ENDS use (current user, lives with a current user, or no-one in the house has ever used ENDS), controlling for demographic characteristics in a convenience sample of U.S. adults. Study 3 builds on Study 2 by examining relationships between risk perceptions of children ($\leq$ 6 years) being exposed to NEL and NEL practices in the home, controlling for current ENDS use (current user or lives with a current user) and demographic characteristics in a convenience sample of U.S. adults. Chapter 5 summarizes the findings of these three studies and discusses implications for future research.

Chapter 2:
Published Manuscript, Study 1: Adults' Perceptions of Nicotine Harm to Children

Embedded PDF: Kemp, C. B., Spears, C. A., Pechacek, T. F., & Eriksen, M. P. (2018). Adults' Perceptions of Nicotine Harm to Children. *Pediatrics, 142*(2).[106]

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS
PEDIATRICS

Adults' Perceptions of Nicotine Harm to Children

Journal:	*Pediatrics*
Manuscript ID	2018-0051.R2
Article Type:	Regular Article
Date Submitted by the Author:	24-Apr-2018
Complete List of Authors:	Kemp, Catherine; Georgia State University School of Public Health, Tobacco Center of Regulatory Science; Georgia State University School of Public Health, Division of Health Promotion & Behavior Spears, Claire; Georgia State University School of Public Health, Division of Health Promotion & Behavior Pechacek, Terry; Georgia State University School of Public Health, Tobacco Center of Regulatory Policy; Georgia State University School of Public Health, Division of Health Management & Policy Eriksen, Michael; Georgia State University School of Public Health, Tobacco Center of Regulatory Policy; Georgia State University School of Public Health, Division of Health Management & Policy
Keyword/Topic:	Substance Abuse, Preventive Medicine

Adults' Perceptions of Nicotine Harm to Children

Catherine B. Kemp, BSN, MHA[a], Claire Adams Spears, PhD[a,b], Terry F. Pechacek, PhD[a,c], and Michael P. Eriksen, ScD[a,c]

Affiliations: [a]Tobacco Center of Regulatory Science (TCORS), Georgia State University School of Public Health, Atlanta, GA 30303; [b]Division of Health Promotion and Behavior, Georgia State University School of Public Health, Atlanta, GA 30303; and [c]Division of Health Management and Policy, Georgia State University School of Public Health, Atlanta GA 30303

Corresponding Author: Catherine B. Kemp, BSN, MHA, Tobacco Center of Regulatory Science (TCORS), Georgia State University School of Public Health, Urban Life Building Room 848, 140 Decatur Street, Atlanta, GA 30303

Short title: Adults' Perceptions of Nicotine Harm to Children

Funding Source: This research was supported by grant number P50DA036128 from the NIH/NIDA and FDA Center for Tobacco Products (CTP) and by grant number K23AT008442 from the NIH/NCCIH. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the FDA.

Financial Disclosure: Michael P. Eriksen receives research funding support from Pfizer, Inc. ("Diffusion of Tobacco Control Fundamentals to Other Large Chinese Cities", Michael P. Eriksen, Principal Investigator). The remaining authors have no financial relationships to disclose.

Conflicts of Interest: The authors have no potential conflicts of interest to disclose.

Abbreviations: ENDS: electronic nicotine delivery systems; e-liquids: Nicotine e-liquids; LCC: little cigars and cigarillos; TC: traditional cigars; NC: non-combustible tobacco products; US: United States; GSU: Georgia State University; CI: confidence interval; *p*: probability; x^2: chi-squared; *df*: degrees of freedom

Table of Contents Summary: Although the majority of American adults characterized nicotine as "definitely harmful" to children, there are important subgroup differences.

What's Known on This Subject: Nicotine can cause significant harms to children. The array of marketed tobacco products and reported cases of child-nicotine exposures have increased substantially in recent years. Comprehension of adults' knowledge and perceptions of nicotine's harmfulness to children is lacking.

What This Study Adds: This study is among the first examining adults' perceptions of nicotine's harms to children, and identifies subgroups that may be less likely to understand these risks. These findings can guide future research, inform policy, and support public health educational interventions.

Contributors' Statement Page

Ms. Kemp and Dr. Spears conceptualized and designed the study, conducted analyses, and wrote the manuscript.

Dr. Eriksen and Dr. Pechacek developed the data collection instrument; oversaw data collection; collaborated on the data analysis plan; and revised the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Abstract

Background: Given the changing landscape of tobacco products in recent years, the array of products through which children could be exposed to nicotine has grown substantially. Thus, it is particularly important to understand adults' perceptions of the harms of nicotine to children and to identify any sociodemographic factors related to inaccurate risk perceptions.

Methods: Data were drawn from 2015 and 2016 U.S. nationally representative surveys (n = 11,959). Multinomial logistic regression analyses examined whether race, sex, education, tobacco product use, and having a minor child in the home are associated with the level of perceived harmfulness of nicotine to children.

Results: Although the majority of respondents characterized nicotine as "definitely harmful" to children, there were notable subgroup differences. Compared to females, males had significantly lower odds of characterizing nicotine as 'definitely harmful' to children. Tobacco product users had significantly lower odds of endorsing 'definitely harmful' or 'don't know' than non-users. Black non-Hispanics, Hispanics, and "Other" non-Hispanics had significantly lower odds of endorsing 'definitely harmful' or 'maybe harmful' than Whites.

Conclusions: Although most adults perceive nicotine exposure as harmful for children, there are important differences based on gender, racial/ethnic background, and tobacco use status. Results highlight the need for public health efforts to better understand and target inaccurate risk perceptions among specific subgroups.

Introduction

The landscape of tobacco use in the United States (US) has changed dramatically in recent years.[1] Although total consumption of combustible cigarettes declined by approximately 39% from 2000 to 2015, consumption of non-cigarette combustible tobacco (e.g., cigars and pipe tobacco) increased by approximately 117% and use of smokeless tobacco products (snuff and chewing tobacco) increased by approximately 23% during the same time period.[1] In addition, use of electronic nicotine delivery systems (ENDS; e.g., e-cigarettes) has increased since these products entered the U.S. market in 2007.[2,3] More than a fifth of American adults have used ENDS to consume vaporized nicotine,[4] and most e-cigarette users also smoke combustible cigarettes (i.e., dual use).[4–7] Among Americans who have ever smoked cigarettes, approximately 38% of current- and 49% of recently former-smokers have used ENDS.[8]

Alternative sources of nicotine consumption have come into focus in recent years as countries such as the US and United Kingdom (UK) have been revising public health policies targeting tobacco harm reduction.[9,10] Public Health England (PHE) has published guidance for employers and organizations to facilitate the use of ENDS to consume nicotine (also known as 'vaping') instead of smoking cigarettes, as part of the UK's national tobacco harm-reduction strategy.[11] The Food and Drug Administration (FDA) in the US recently announced that they would be placing greater emphasis on reducing nicotine standards for cigarettes to non-addictive levels in an effort to pursue a regulatory framework "that recognizes that the core problem of nicotine lies not in the drug itself but in the risk associated with the delivery mechanism"[9(p1111)]. The common theme is that alternative sources of nicotine are being encouraged to reduce exposure to smoked tobacco products. Indeed, recent studies indicate that many smokers are

Introduction

The landscape of tobacco use in the United States (US) has changed dramatically in recent years.[1] Although total consumption of combustible cigarettes declined by approximately 39% from 2000 to 2015, consumption of non-cigarette combustible tobacco (e.g., cigars and pipe tobacco) increased by approximately 117% and use of smokeless tobacco products (snuff and chewing tobacco) increased by approximately 23% during the same time period.[1] In addition, use of electronic nicotine delivery systems (ENDS; e.g., e-cigarettes) has increased since these products entered the U.S. market in 2007.[2,3] More than a fifth of American adults have used ENDS to consume vaporized nicotine,[4] and most e-cigarette users also smoke combustible cigarettes (i.e., dual use).[4–7] Among Americans who have ever smoked cigarettes, approximately 38% of current- and 49% of recently former-smokers have used ENDS.[8]

Alternative sources of nicotine consumption have come into focus in recent years as countries such as the US and United Kingdom (UK) have been revising public health policies targeting tobacco harm reduction.[9,10] Public Health England (PHE) has published guidance for employers and organizations to facilitate the use of ENDS to consume nicotine (also known as 'vaping') instead of smoking cigarettes, as part of the UK's national tobacco harm-reduction strategy.[11] The Food and Drug Administration (FDA) in the US recently announced that they would be placing greater emphasis on reducing nicotine standards for cigarettes to non-addictive levels in an effort to pursue a regulatory framework "that recognizes that the core problem of nicotine lies not in the drug itself but in the risk associated with the delivery mechanism"[9(p1111)]. The common theme is that alternative sources of nicotine are being encouraged to reduce exposure to smoked tobacco products. Indeed, recent studies indicate that many smokers are

utilizing non-cigarette tobacco products such as ENDS to either aid cessation or provide a less harmful alternative to smoking,[4–7] although the efficacy of these products for smoking cessation is unclear.[12–15]

While certain modes of nicotine delivery may reduce smoking-caused harm for adults, both acute and chronic exposures to nicotine are known to cause significant harms to children from fetal development through birth, childhood, and adolescence.[16–20] Unintended direct nicotine exposures among children from handling or ingesting tobacco products such as cigarettes, cigars, nicotine e-liquids used in ENDS, nicotine gums, and other non-cigarette nicotine products have been increasing steadily and significantly over the past decade in the U.S.,[21,22] resulting in clinical sequelae ranging from mild illness to death.[21–23] While it would be ideal if all adults possessed a basic understanding of nicotine's harmfulness to children, there are likely more acute needs and information deficits among specific sub-groups of the population contributing to this problem. Research is needed to identify at-risk subgroups (e.g., adults who underestimate the risks of nicotine to children) in order to develop targeted public health interventions to protect children from nicotine exposure.

Research documenting adults' risk perceptions regarding children being exposed to nicotine is limited. Although studies have examined adults' perceptions of the risks of secondhand smoke to infants and children,[24,25] there is a dearth of research on perceptions of specific harms of nicotine (not necessarily in the context of combustible cigarettes or secondhand smoke) to children. One published study[26] examined risk perceptions regarding nicotine exposure from ENDS e-liquids among parents of child patients in an urban pediatric practice. Although most parents believed that child exposure to nicotine e-liquids would be dangerous,

many of the parents who used ENDS did not have adequate knowledge about nicotine-specific harms to children, and e-liquid safe-storage practices were inconsistent.[26]

Given the increasing array of sources of nicotine exposure (including not only combustible and smokeless tobacco products but also nicotine e-liquids, which have recently become potentially dangerous sources of child exposure), research is needed to examine adults' perceptions of the specific harms of nicotine to children. Thus, the current study sought to examine whether demographic and/or behavioral factors (e.g., current tobacco use status, having a minor child in the home, level of education) are related to perceptions of nicotine harm to children. Perceptions of nicotine harm to children were assessed generally, regardless of mode of exposure. If there are specific subgroups of adults (e.g., tobacco users, those with lower education) who perceive less danger of nicotine to children, this would be important for informing targeted educational interventions to protect children from nicotine exposure.

Sample and Methods

Sample

Data were obtained from two waves of the Tobacco Products and Risk Perceptions Survey administered annually by the Georgia State University (GSU) Tobacco Center of Regulatory Science (TCORS). Data collection occurred August-September 2015 and August-September 2016; samples were drawn from GfK's KnowledgePanel, a probability-based web panel designed to be representative of non-institutionalized US adults. Details regarding sampling and weighting procedures are documented elsewhere.[27] This study included

participants providing responses to all study questions (n = 11,948; 99.0% of total sample) and was approved by the GSU Institutional Review Board.

Measures

Demographics

Age ('18-29 years,' '30-44 years,' '45-59 years,' and 'over 60 years'), sex, education ('less than high school,' 'high school graduate,' 'some college,' and 'bachelor's degree or higher'), and whether at least one minor (<18 years) child resided in the home were assessed.

Tobacco Product Use

Participants who indicated that they had not smoked at least 100 cigarettes in their life were categorized as 'non-smokers.' Among respondents who had smoked 100 cigarettes in their life: those who currently smoked some days or every day were characterized as 'current' smokers; those not currently smoking were categorized as 'non-smokers.' Participants responding "no" to: "Have you ever ['used electronic vapor products'; 'smoked little cigars, cigarillos, or filtered cigars' (LCC); 'smoked traditional cigars' (TC)], even one or two times?" were classified as non-users of the particular product. Those responding "yes" were asked, "Do you now ['use electronic vapor products'; 'smoke little cigars, cigarillos, or filtered cigars'; 'smoke traditional cigars'] some days, every day, or not at all?" Those responding 'some days' or 'every day' were categorized as *current product users*, and those responding 'not at all' were categorized as *non-users*. A dichotomous *combusted tobacco product* variable combining the responses for cigarettes, LCC, and traditional cigars was calculated to represent current use of smoked tobacco products. For current use of other non-combustible tobacco products (NC), participants were asked if in the last 30 days they had "used any of the following: chewing

tobacco, dip or snuff, snus, or dissolvable tobacco." Finally, a variable was computed to represent the total number of tobacco product types currently used (0, 1, or 2 or more, regardless of combustible or non-combustible) by each respondent.

Perceptions of Nicotine Harm to Children

The following question elicited perceptions of nicotine harm to children: "Tobacco products, including electronic vapor products, contain nicotine. When used by the following groups, how harmful is nicotine in amounts usually found in tobacco products?", regarding children less than 13 years old. Response options were: "not harmful," "unlikely harmful," "maybe harmful," "definitely harmful," or "don't know."

Data Analysis

Using SAS software, version 9.4 (©2012, The SAS Institute, Cary, NC), we compared the two waves of data for variations in the patterns of bivariate associations between each of the explanatory variables and the outcome of interest; because no substantial differences were found, the two samples were combined for this analysis. First, descriptive statistics and chi-squared (x^2) tests were used to examine bivariate associations between demographic characteristics (age, sex, education, race/ethnicity, having at least 1 minor child in the home), tobacco product use (combusted tobacco use, non-combusted tobacco use, ENDS use, number of different tobacco products currently used), and perceptions of nicotine harm to children. Next, multinomial logistic regression models examined adjusted relationships between demographic characteristics, number of different tobacco products currently used, and perceptions of nicotine harm to children. The decision to examine the number of tobacco products used in multivariate analyses, rather than

variables representing each individual tobacco product, was based in part on multi-collinearity; nearly half of cigarette smokers (44.7% 95% CI: 41.9, 47.5) and NC users (48.5% 95% CI: 41.7, 55.2), and more than half of ENDS users (71.7%, 95% CI: 67.4, 76.0), LCC smokers (84.0%, 95% CI: 80.6, 87.5), and TC smokers (56.1%, 95% CI: 52.1, 60.0) were current multiple tobacco product users. Furthermore, the research question related to children's exposure to nicotine rather than particular product types.

Results

The majority (83.2%; 95% CI: 82.3, 84.1) of adults characterized nicotine as "definitely harmful" to children, 6.2% (95% CI: 5.7, 6.8) as "maybe harmful," 1.7% (95% CI: 1.3, 2.0) as "unlikely harmful," 0.6% (95% CI: 0.4, 0.8) as "not harmful," and 8.3% (95% CI: 7.6, 9.0) responded that they "don't know" how harmful nicotine is when used by children. About one-third of current tobacco product users (32.8%; 95% CI: 30.7, 34.9) reported having at least one minor child living in their home.

Bivariate associations of demographic and tobacco use variables with perceptions of nicotine harm to children are summarized in Table 1. There were significant associations between sex, race/ethnicity, age, education, combusted tobacco use status, non-combusted tobacco product use status, ENDS use, and number of nicotine products currently used with perceptions of nicotine harm to children. For example, Black non-Hispanic adults were significantly less likely to characterize nicotine as being "definitely harmful" to children, and significantly more likely to respond "don't know," compared to those of other racial/ethnic backgrounds. In addition, respondents with either less than a high school diploma, a high school

diploma, or some college were significantly less likely to perceive nicotine as being "definitely" harmful to children, compared to those with a Bachelor's degree or higher.

INSERT TABLE 1 HERE

The multinomial logistic regression model was statistically significant, F (56, 11497) = 8.85, $p < .0001$. The reference category for the dependent variable was set as "unlikely harmful." With the exception of having at least one minor child in the home, all explanatory variables were significantly associated with nicotine risk perceptions in the overall model (gender: F (4, 11944) = 5.12, $p = .0004$; race/ethnicity: F (12, 11936) = 5.38, $p < .0001$; education: F (12, 11936) = 5.47, $p < .0001$; age category: F (12, 11936) = 1.82, $p = .04$; having a minor child in the home: F (4, 11944) = 1.02, $p = .40$; number of nicotine products currently used: F (8, 11940) = 18.04, $p < .0001$). Adjusted odds ratios for all covariates in the model are presented in Table 2. Significant inter-category differences were observed for gender, race/ethnicity and number of tobacco products in the full model. Tobacco product users had significantly lower odds of endorsing 'definitely harmful' or 'don't know' than non-users, and Black non-Hispanics, Hispanics, and "Other" non-Hispanics had significantly lower odds of endorsing 'definitely harmful' or 'maybe harmful' than Whites. Compared to females, males had significantly lower odds of characterizing nicotine as 'definitely harmful' to children.

INSERT TABLE 2 HERE

Discussion

This study analyzed US adults' perceptions of nicotine harm to children in a nationally representative sample and found that while the majority of the population perceived nicotine to be harmful when used by children, important subgroup variations exist. For example, the finding

that regardless of the number of different products used, adults who use tobacco are significantly more likely to underestimate nicotine's harmfulness to children is particularly concerning. These individuals have the greatest likelihood of possessing nicotine-containing products, providing potential sources of exposure to children. Results also suggest that some males and individuals from racial/ethnic minority backgrounds might benefit from interventions to correct inaccurate risk perceptions.

Previously published research has demonstrated that after cigarettes, ENDS products[21,22] and chewing tobacco[21] have been the principle sources of unintended nicotine exposure in children since 2012. The increasing use of ENDS and other non-combusted tobacco products in the US adult population[1–5] presents new sources of nicotine consumption and exposure not only to the users, but also to the children who live with them. The food-grade flavorings used in these products include many fruit and candy flavors that are appealing to children.[28] The number of cases of nicotine poisonings resulting from children ingesting e-liquids has risen sharply in recent years.[21,22,29] Although there was a 21% reduction in the number of reported e-liquid exposures in the months after a Federal statute for childproof packaging became effective in July 2016, several hundred such exposures continue to be reported monthly in the US.[29] These trends highlight the need for interventions targeting tobacco product users and adults who live with them to educate them on the dangers of child nicotine exposure (from e-liquids as well as other sources) and how to prevent it.

Based on the current findings, such interventions might target specific subgroups. For example, members of racial/ethnic minority groups (compared to White adults) and adult males had significantly lower odds of characterizing nicotine as being harmful to children. In addition,

adults who use tobacco products were significantly less likely to state that nicotine is harmful to children, compared to adults who didn't use tobacco products.

This study and Garbutt et al.[26] both found that the majority of adults perceived nicotine exposure among children as harmful. Other published studies examining nicotine-specific risk perceptions (i.e., without a more general focus on tobacco use) have often focused on its addictiveness and/or harm to developing fetuses[30–32]; such studies generally consider inhaled rather than ingested nicotine or cutaneous exposures. Studies have examined agricultural workers' perceptions related to "green tobacco sickness" (nicotine toxicity resulting from dermal nicotine absorption that occurs during tobacco harvesting on farms[33]) resulting from handling tobacco plant constituents. These studies have documented knowledge deficits related to the potential for nicotine toxicity among children working in tobacco fields and a tendency to attribute symptoms to factors other than nicotine exposure such as heat and fatigue.[34–37] Thus, the current research is an important addition to the literature on perceptions about specific harms of nicotine to children. This topic is timely with the recent increase in availability of different sources of nicotine, such as nicotine e-liquids and other non-cigarette tobacco products. Awareness of these findings is particularly important for pediatricians and others providing healthcare to children and their families.

This study has limitations. The primary outcome was a response to a general question of nicotine being harmful when used by children under the age of 13 years, and although our analysis controlled for number of tobacco products currently used, this study did not assess harm perceptions specific to nicotine product type. In a similar vein, participants' responses may or may not be applicable across different modes of nicotine exposure such as ingestion, second-hand inhalation, or absorption through the skin and mucous membranes. Garbutt et al.[26] found

that while 73.7% of adults thought e-liquid ingestion was dangerous to children, less than half that many (31.2%) thought exposure by skin contact would be very dangerous. These findings suggest that knowledge deficits vary according to routes of nicotine e-liquid exposure. Future research examining risk perceptions relative to specific sources and routes of nicotine exposure would be helpful in clarifying these differences.

These findings are limited in that the dependent variable assessed respondents' perceptions of nicotine's harmfulness to children less than 13 years old. We were unable to determine how risk perceptions might vary relative to specific child age ranges below 13 years (e.g., age 6 and younger, given that more than half the reported nicotine e-liquid exposures occur in this age group[38]). Future research should attempt to identify how adults' perceptions of nicotine harm to children may vary depending on specific child age ranges.

Conclusion

Although most adults perceive nicotine as harmful to children, there are important differences based on racial/ethnic background and tobacco use status. Given the rapid expansion of potential sources of nicotine exposure (i.e., increases in use of non-cigarette tobacco products as well as ENDS), public health efforts are needed to better understand and target inaccurate risk perceptions among males, tobacco users and certain racial/ethnic minorities. Adults' knowledge of risks associated with unintended nicotine exposures (including ingestion, and absorption through skin and mucous membranes) particularly regarding children, has received sporadic attention in the scientific literature. Adding to this, ENDS are widely viewed in the context of cigarette smoking,[4–7] and (in this context) are perceived as being safe. Research focused on perceptions of the harm of children's exposure to sources of nicotine (including cigarettes,

cigarette butts, all types of cigars, hookahs, chewing tobacco, snuff, and ENDS e-liquids) and how these materials are handled and stored in the presence of children is needed to identify risk factors associated with such exposures. Such inquiries should include nicotine product users and adults who live with them to assess knowledge of safety issues related to having these products in their homes.

References

1. Wang TW, Kenemer B, Tynan MA, Singh T, King B. Consumption of Combustible and Smokeless Tobacco - United States, 2000-2015. *MMWR Morb Mortal Wkly Rep*. 2016;65(48):1357-1363. doi:10.15585/mmwr.mm6548a1

2. King BA, Alam S, Promoff G, Arrazola R, Dube SR. Awareness and ever-use of electronic cigarettes among U.S. adults, 2010-2011. *Nicotine Tob Res*. 2013;15(9):1623-1627. doi:10.1093/ntr/ntt013

3. King BA, Patel R, Nguyen KH, Dube SR. Trends in awareness and use of electronic cigarettes among US adults, 2010-2013. *Nicotine Tob Res*. 2015;17(2):219-227. doi:10.1093/ntr/ntu191

4. Pericot-Valverde I, Gaalema DE, Priest JS, Higgins ST. E-cigarette awareness, perceived harmfulness, and ever use among U.S. adults. *Prev Med*. July 2017. doi:10.1016/j.ypmed.2017.07.014

5. Hammett E, Veldheer S, Yingst J, Hrabovsky S, Foulds J. Characteristics, use patterns and perceptions of electronic cigarette users who were never traditional cigarette smokers. *Addict Behav*. 2017;65:92-97. doi:10.1016/j.addbeh.2016.10.007

6. Cooper M, Harrell MB, Perry CL. A qualitative approach to understanding real-world electronic cigarette use: Implications for measurement and regulation. *Prev Chronic Dis*. 2016;13:E07. doi:10.5888/pcd13.150502

7. Pepper J, Emery S, Ribisl K, Rini C, Brewer N. How risky is it to use e-cigarettes? Smokers' beliefs about their health risks from using novel and traditional tobacco products. *J Behav Med*. 2015;38(2):318-326 9p. doi:10.1007/s10865-014-9605-2

8. Zhu S-H, Zhuang Y-L, Wong S, Cummins SE, Tedeschi GJ. E-cigarette use and associated changes in population smoking cessation: evidence from US current population surveys. *The BMJ*. 2017;358(j3262). doi:10.1136/bmj.j3262

9. Gottlieb S, Zeller M. A Nicotine-Focused Framework for Public Health. *N Engl J Med*. 2017;377(12):1111-1114. doi:10.1056/NEJMp1707409

10. Public Health England. *Towards a Smokefree Generation - A Tobacco Control Plan for England*. London, UK: Division of Global and Public Health, Public Health England; 2017:1-32. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/630217/Towards_a_Smoke_free_Generation_-_A_Tobacco_Control_Plan_for_England_2017-2022__2_.pdf.

11. *Use of E-Cigarettes in Public Places and Workplaces: Advice to Inform Evidence-Based Policy Making*. London, UK: Public Health England; 2016:15. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/534586/PHE-advice-on-use-of-e-cigarettes-in-public-places-and-workplaces.PDF.

12. Malas M, van der Tempel J, Schwartz R, et al. Electronic cigarettes for smoking cessation: A systematic review. *Nicotine Tob Res*. 2016;18(10):1926-1936. doi:10.1093/ntr/ntw119

13. Hartmann-Boyce J, McRobbie H, Bullen C, Begh R, Stead LF, Hajek P. Electronic cigarettes for smoking cessation. *Cochrane Database Syst Rev*. 2016;9:CD010216. doi:10.1002/14651858.CD010216.pub3

14. McRobbie H, Bullen C, Hartmann-Boyce J, Hajek P. Electronic cigarettes for smoking cessation and reduction. *Cochrane Database Syst Rev*. 2014;(12). doi:10.1002/14651858.CD010216.pub2

15. Kalkhoran S, Glantz SA. E-cigarettes and smoking cessation in real-world and clinical settings: A systematic review and meta-analysis. *Lancet Respir Med*. 2016;4(2):116-128. doi:10.1016/S2213-2600(15)00521-4

16. England LJ, Bunnell RE, Pechacek TF, Tong VT, McAfee TA. Nicotine and the developing human: A neglected element in the electronic cigarette debate. *Am J Prev Med*. 2015;49(2):286-293. doi:10.1016/j.amepre.2015.01.015

17. Connolly GN, Richter P, Aleguas A Jr, Pechacek TF, Stanfill SB, Alpert HR. Unintentional child poisonings through ingestion of conventional and novel tobacco products. *Pediatrics*. 2010;125(5):896-899. doi:10.1542/peds.2009-2835

18. Tiesler C, Heinrich J. Prenatal nicotine exposure and child behavioural problems. *Eur Child Adolesc Psychiatry*. 2014;23(10):913-929.

19. England LJ, Aagaard K, Bloch M, et al. Developmental toxicity of nicotine: A transdisciplinary synthesis and implications for emerging tobacco products. *Neurosci Biobehav Rev*. 2017;72:176-189. doi:10.1016/j.neubiorev.2016.11.013

20. Talati A, Wickramaratne PJ, Wesselhoeft R, Weissman MM. Prenatal tobacco exposure, birthweight, and offspring psychopathology. *Psychiatry Res*. 2017;252:346-352. doi:10.1016/j.psychres.2017.03.016

21. Wang B, Rostron B. Tobacco-related Poison Events Involving Young Children in the US, 2001-2016. *Tob Regul Sci*. 2017;3(4):525-535.

22. Kamboj A, Spiller HA, Casavant MJ, Chounthirath T, Smith GA. Pediatric Exposure to E-Cigarettes, Nicotine, and Tobacco Products in the United States. *Pediatrics*. 2016;137(6). doi:10.1542/peds.2016-0041

23. Forrester MB. Original Contributions: Pediatric Exposures to Electronic Cigarettes Reported to Texas Poison Centers. *J Emerg Med*. 2015;49:136-142.

24. Bock BC, Becker BM, Borrelli B. Smoking behavior and risk perception among the parents of infants in the neonatal intensive care unit. *Nicotine Tob Res Off J Soc Res Nicotine Tob*. 2008;10(1):47-54. doi:10.1080/14622200701767795

25. Wagener TL, Gregor KL, Busch AM, McQuaid EL, Borrelli B. Risk perception in smokers with children with asthma. *J Consult Clin Psychol*. 2010;78(6):980-985. doi:10.1037/a0021094

26. Garbutt JM, Miller W, Dodd S, Bobenhouse N, Sterkel R, Strunk RC. Tobacco and Substance Abuse: Parental Use of Electronic Cigarettes. *Acad Pediatr*. 2015;15:599-604.

27. Spears CA, Jones DM, Weaver SR, Pechacek TF, Eriksen M. Use of Electronic Nicotine Delivery Systems among Adults with Mental Health Conditions, 2015. *Int J Environ Res Public Health*. 2016;14(1):10. doi:10.3390/ijerph14010010

28. Ambrose BK, Day HR, Rostron B, et al. Flavored Tobacco Product Use Among US Youth Aged 12-17 Years, 2013-2014. *JAMA*. 2015;314(17):1871-1873. doi:10.1001/jama.2015.13802

29. *Electronic Cigarettes and Liquid Nicotine Data*. Alexandria, VA: American Association of Poison Control Centers (AAPCC); 2018:1-6. https://aapcc.s3.amazonaws.com/files/library/E-cig__Nicotine_Web_Data_through_2.2018_uX7yR7G.pdf. Accessed March 3, 2018.

30. Czoli CD, Fong GT, Mays D, Hammond D. How do consumers perceive differences in risk across nicotine products? A review of relative risk perceptions across smokeless tobacco, e-cigarettes, nicotine replacement therapy and combustible cigarettes. *Tob Control*. 2017;26(e1):e49-e58. doi:10.1136/tobaccocontrol-2016-053060

31. Black A, Beard E, Brown J, Fidler J, West R. Beliefs about the harms of long-term use of nicotine replacement therapy: perceptions of smokers in England. *Addiction*. 2012;107(11):2037-2042. doi:10.1111/j.1360-0443.2012.03955.x

32. England LJ, Tong VT, Koblitz A, Kish-Doto J, Lynch MM, Southwell BG. Perceptions of emerging tobacco products and nicotine replacement therapy among pregnant women and women planning a pregnancy. *Prev Med Rep*. 2016;4:481-485. doi:10.1016/j.pmedr.2016.09.002

33. Green Tobacco Sickness. *NIOSH Workplace Saf Health Top*. 2015. https://www.cdc.gov/niosh/topics/greentobaccosickness/default.html. Accessed January 2, 2018.

34. Arcury TA, Quandt SA, Simmons S. Farmer health beliefs about an occupational illness that affects farmworkers: the case of green tobacco sickness. *J Agric Saf Health*. 2003;9(1):33-45.

35. Ballard T, Ehlers J, Freund E, Auslander M, Brandt V, Halperin W. Green Tobacco Sickness: Occupational Nicotine Poisoning in Tobacco Workers. *Arch Environ Health Int J*. 1995;50(5):384-389. doi:10.1080/00039896.1995.9935972

36. McKnight RH, Spiller HA. Green Tobacco Sickness in Children and Adolescents. *Public Health Rep*. 2005;120(6):602-606.

37. Rm P, Quandt SA, A.Arcury T. Hispanic Farmworker Interpretations of Green Tobacco Sickness. *J Rural Health*. 2002;18(4):503.

38. E-cigarettes and liquid nicotine. AAPCC. http://www.aapcc.org/alerts/e-cigarettes/. Published February 28, 2018.

Table 1. US adults' perceptions of nicotine harmfulness to children by demographic, and number and type of tobacco products used characteristics.

	Adjusted Percent (95% CI)	Perceptions of nicotine harmfulness to children less than 13 years old (percent)					
		Definitely (95% CI)	Maybe (95% CI)	Unlikely (95% CI)	Not (95% CI)	Don't know (95% CI)	$p\ (x^2_{df})$
Overall		83.2 (82.3, 84.1)	6.2 (5.7, 6.8)	1.7 (1.3, 2.0)	0.6 (0.4, 0.8)	8.3 (7.6, 9.0)	<.0001
Sex							
Male	48.1 (47.0, 49.3)	**81.5 (80.2, 82.8)**	**7.6 (6.8, 8.4)**	2.1 (1.6, 2.6)	0.6 (0.3, 0.9)	8.2 (7.2, 9.1)	<.0001
Female	51.9 (50.7, 53.0)	84.8 (83.5, 86.0)	5.0 (4.2, 5.7)	1.3 (0.9, 1.7)	0.6 (0.3, 0.9)	8.4 (7.5, 9.4)	
Race/Ethnicity							
White, non-Hispanic	64.9 (63.7, 66.0)	84.9 (84.0, 85.9)	6.5 (5.9, 7.2)	1.0 (0.7, 1.3)	0.4 (0.3, 0.6)	7.1 (6.4, 7.8)	<.0001
Black, non-Hispanic	11.8 (11.0, 12.6)	**76.0 (72.8, 79.3)**	6.4 (4.6, 8.3)	**2.4 (1.3, 3.5)**	0.9 (0.0, 1.8)	**14.2 (11.5, 16.9)**	
Hispanic	15.5 (14.6, 16.4)	82.7 (80.2, 85.1)	5.2 (3.9, 6.4)	**2.6 (1.6, 3.7)**	1.0 (0.3, 1.7)	8.6 (6.6, 10.5)	
Other (including mixed race)	7.8 (7.0, 8.5)	80.7 (76.5, 85.0)	5.7 (3.2, 8.3)	**4.3 (1.9, 6.6)**	0.8 (0.0, 1.9)	8.5 (5.6, 11.4)	
Age (four categories)							
18-29 years	20.9 (19.9, 21.9)	**82.6 (79.9, 83.7)**	6.1 (4.8, 7.4)	**2.5 (1.5, 3.5)**	0.9 (0.3, 1.5)	7.8 (6.3, 9.3)	.002
30-44 years	24.9 (23.9, 25.9)	**81.8 (79.9, 83.7)**	6.1 (4.9, 7.2)	**2.3 (1.5, 3.5)**	0.7 (0.3, 1.0)	9.2 (7.8, 10.7)	
45-59 years	26.5 (25.5, 27.5)	82.5 (80.8, 84.2)	7.5 (5.4, 8.7)	1.2 (0.7, 1.7)	0.4 (0.2, 0.7)	8.3 (7.1, 9.6)	
60 years and older	27.6 (26.7, 28.6)	85.5 (84.1, 87.0)	5.3 (4.5, 6.1)	1.0 (0.5, 1.5)	0.4 (0.1, 0.8)	7.8 (6.6, 8.9)	
Education (four categories)							
Less than high school diploma	11.4 (10.4, 12.3)	**75.3 (71.4, 79.2)**	**9.1 (6.5, 11.7)**	1.9 (0.8, 3.0)	1.4 (0.3, 2.5)	**12.3 (9.2, 15.4)**	<.0001
High school diploma	29.2 (28.2, 30.2)	**81.6 (80.1, 83.2)**	6.0 (5.1, 6.9)	1.6 (0.9, 2.2)	0.9 (0.4, 1.3)	**9.9 (8.7, 11.1)**	
Some college	28.6 (27.6, 29.6)	**83.7 (82.2, 85.3)**	6.4 (5.4, 7.3)	1.8 (1.2, 2.5)	0.3 (0.1, 0.5)	7.8 (6.6, 8.9)	
Bachelor's degree or higher	30.8 (29.8, 31.9)	87.0 (85.7, 88.4)	5.3 (4.4, 6.1)	1.5 (1.0, 2.1)	0.3 (0.1, 0.5)	5.9 (4.9, 6.8)	
Child < 18 years in the home							
None	70.1 (69.0, 71.1)	83.1 (82.0, 84.1)	6.5 (5.8, 7.1)	1.6 (1.2, 1.9)	0.5 (0.3, 0.8)	8.3 (7.5, 9.1)	0.55
At least one	29.9 (28.9, 31.0)	83.5 (81.8, 85.2)	5.6 (4.6, 6.7)	1.9 (1.3, 2.6)	0.7 (0.3, 1.1)	8.2 (7.0, 9.5)	
Number of tobacco products currently used							
None	75.9 (74.9, 76.1)	86.1 (85.1, 87.0)	4.4 (3.8, 4.9)	1.1 (0.8, 1.5)	0.4 (0.2, 0.6)	8.0 (7.3, 8.8)	<.0001
1	15.3 (14.5, 16.1)	**74.6 (70.5, 76.8)**	**11.9 (10.0, 13.8)**	**3.1 (2.0, 4.2)**	0.5 (0.2, 0.9)	9.9 (8.2, 11.6)	
2 or more	8.8 (8.2, 9.5)	**73.7 (70.5, 76.8)**	**12.5 (10.2, 14.9)**	**3.8 (2.5, 5.1)**	**2.3 (0.9, 3.6)**	7.7 (5.9, 9.5)	
Current use of combusted tobacco product (incl. cigarettes, little cigars, cigarillos, and traditional cigars)							
Yes	20.9 (20.0, 21.8)	**73.8 (71.7, 75.9)**	**11.9 (10.3, 13.4)**	**3.4 (2.6, 4.3)**	1.2 (0.6, 1.8)	9.7 (8.4, 11.1)	<.0001
No	79.1 (78.2, 80.0)	85.7 (84.7, 86.7)	4.8 (4.2, 5.3)	1.2 (0.9, 1.6)	0.4 (0.2, 0.6)	7.9 (7.2, 8.7)	
Current use of ENDS							
Yes	6.4 (5.8, 6.9)	**70.9 (66.9, 75.0)**	**15.5 (12.3, 18.7)**	**3.8 (2.0, 5.6)**	**2.4 (0.9, 3.9)**	7.3 (5.3, 9.4)	<.0001
No	93.6 (93.1, 94.2)	84.0 (83.1, 84.9)	5.6 (5.1, 6.2)	1.5 (1.2, 1.9)	0.5 (0.3, 0.7)	8.4 (7.7, 9.1)	
Current use of non-combusted tobacco product (incl. chewing tobacco, dip or snuff, snus, or dissolvable tobacco)							
Yes	3.1 (2.7, 3.5)	**76.3 (70.8, 81.9)**	10.6 (6.5, 14.6)	**5.9 (3.8, 9.0)**	2.4 (0.2, 4.7)	**4.8 (2.4,7.1)**	<.0001
No	96.9 (96.5, 97.3)	83.4 (82.5, 84.3)	6.1 (5.6, 6.7)	1.5 (1.2, 1.9)	0.5 (0.3, 0.7)	8.4 (7.7, 9.1)	

Parameter estimates are weighted to be representative of the non-institutionalized US adult population. Perceptions of nicotine harm to children were elicited with the following question: "Tobacco products, including electronic vapor products, contain nicotine. When used by the following groups, how harmful is nicotine in amounts usually found in tobacco products?", regarding children less than 13 years old. Response options were: "not harmful," "unlikely harmful," "maybe harmful," "definitely harmful," or "don't know."

Table 2. Multinomial logistic regression model examining associations between demographic factors and number of tobacco products currently used with US adults' perceptions of nicotine's harmfulness to children less than 13 years old ($N = 11948$).

Predictor		Definitely harmful[d] Adjusted OR[a,c] (95% CI[b])	Maybe harmful[d] Adjusted OR[a,c] (95% CI[b])	Not harmful[d] Adjusted OR[a,c] (95% CI[b])	Don't know[d] Adjusted OR[a,c] (95% CI[b])
Sex[e]					
	Female	**1.6 (1.0, 2.4)**	1.1 (0.9, 2.2)	1.4 (0.6, 3.2)	1.4 (0.9, 2.2)
	Male	*reference*	*reference*	*reference*	*reference*
Race/ethnicity[e]					
	White, non-Hispanic	*reference*	*reference*	*reference*	*reference*
	Black, non-Hispanic	**0.4 (0.2, 0.7)**	**0.4 (0.2, 0.7)**	0.8 (0.2, 2.4)	0.8 (0.5, 1.5)
	Hispanic	**0.4 (0.3, 0.7)**	**0.3 (0.2, 0.6)**	0.9 (0.3, 2.4)	**0.5 (0.3, 0.9)**
	Other, non-Hispanic	**0.2 (0.1, 0.5)**	**0.2 (0.1, 0.5)**	0.5 (0.1, 2.3)	**0.3 (0.1, 0.7)**
Age (four categories) [e]					
	18-29 years	0.6 (0.3, 1.2)	0.6 (0.3, 1.3)	1.0 (0.2, 4.5)	0.6 (0.3, 1.4)
	30-44 years	0.6 (0.3, 1.1)	0.7 (0.3, 1.4)	0.8 (0.2, 3.5)	0.8 (0.4, 1.7)
	45-59 years	1.1 (0.5, 2.1)	1.4 (0.7, 2.9)	0.9 (0.2, 3.4)	1.2 (0.6, 2.4)
	60 and over	*reference*	*reference*	*reference*	*reference*
Education (four categories) [e]					
	Bachelor's degree or higher	*reference*	*reference*	*reference*	*reference*
	Some college	0.8 (0.4, 1.4)	1.0 (0.5, 1.7)	0.7 (0.2, 2.0)	1.1 (0.6, 2.0)
	High school diploma	0.7 (0.4, 1.3)	0.9 (0.5, 1.7)	2.3 (0.8, 6.5)	1.3 (0.7, 2.6)
	Less than high school	0.7 (0.4, 1.5)	1.4 (0.6, 3.1)	3.0 (0.8, 10.7)	1.8 (0.8, 3.8)
Has at least 1 child under 18 years in the home[e]					
	Yes	1.0 (0.7, 1.6)	0.8 (0.5, 1.4)	1.0 (0.4, 2.5)	0.9 (0.6, 1.5)
	No	*reference*	*reference*	*reference*	*reference*
Number of tobacco products currently used[e]					
	None	*reference*	*reference*	*reference*	*reference*
	1	**0.3 (0.2, 0.5)**	1.0 (0.6, 1.6)	0.5 (0.2, 1.2)	**0.4 (0.3, 0.7)**
	2 or more	**0.3 (0.2, 0.5)**	1.0 (0.5, 1.7)	1.6 (0.6, 4.5)	**0.3 (0.2, 0.6)**

[a]OR = odds ratio; [b]CI = confidence interval.

[c]Parameter estimates obtained using the surveylogistic procedure with glogit link in SAS Software, version 9.4 (©2012, The SAS Institute, Cary, NC), and weighted to be representative of non-institutionalized US adult population.

[d]Perceptions of nicotine harm to children were elicited with the following question: "Tobacco products, including electronic vapor products, contain nicotine. When used by the following groups, how harmful is nicotine in amounts usually found in tobacco products?", regarding children less than 13 years old. Response options were: "not harmful," "unlikely harmful," "maybe harmful," "definitely harmful," or "don't know." The reference category in this analysis is "unlikely harmful".

[e]The reference categories for the explanatory variables are noted in the table.

Chapter 3:
Study 2 Manuscript: Vapers' Harm Perceptions of Child Exposure to Nicotine E-liquids

Formatted according to criteria listed by the journal *Pediatrics*

Vapers' Harm Perceptions of Child Exposure to Nicotine E-liquids

Authors: Catherine B. Kemp, BSN, MHA[a,b], Claire Adams Spears, Ph.D.[a,b], David L. Ashley, Ph.D.[a,c] and Terry F. Pechacek, Ph.D.[a,d],

Author Affiliations:
[a] Tobacco Center of Regulatory Science (TCORS), Georgia State University School of Public Health, Atlanta, GA 30303;
[b] Division of Health Promotion and Behavior, Georgia State University School of Public Health, Atlanta, GA 30303;
[c] Division of Environmental Health, Georgia State University School of Public Health, Atlanta, GA 30303.
[d] Division of Health Management and Policy, Georgia State University School of Public Health, Atlanta, GA 30303.

Corresponding Author:
Catherine B. Kemp, BSN, MHA
Tobacco Center of Regulatory Science (TCORS)
Georgia State University School of Public Health
Urban Life Building Room 848
140 Decatur Street
Atlanta, GA 30303

Short title: Vapers' Harm Perceptions of Childhood Nicotine Exposure

Funding Source: This research was supported by grant number P50DA036128 from the NIH/NIDA and FDA Center for Tobacco Products (CTP) and by grant number K23AT008442 from the NIH/NCCIH. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the FDA.

Financial Disclosure: The authors have no financial relationships relevant to this article to disclose.

Potential Conflict of Interest: The authors have no potential or actual conflicts of interest relevant to this article to disclose.

Abbreviations: EVP- electronic vapor products; NEL- Nicotine e-liquids; US- United States; CL- confidence limits; *p*- probability; x^2- chi-squared; *df* - degrees of freedom; MTurk- Amazon Mechanical Turk

Table of Contents Summary

We examined adults' harm perceptions of child exposures to nicotine e-liquids used in electronic vaping products (EVP) at two doses, by five modes of exposure.

What's Known on This Subject

EVPs are increasingly being used by adults as a "safe" alternative to smoking. Flavored, nicotine-containing e-liquids in EVPs typically have high nicotine concentrations. Instances of children being exposed to them have increased in recent years, with sometimes severe consequences.

What This Study Adds

Among the first which specifically examines adults' perceptions of nicotine e-liquid harms to children, this study found that EVP users have lower estimates (versus non-users) of potential harms to children across modes and doses of exposure.

Contributors' Statement Page

Ms. Kemp conceptualized and designed the study, administered the survey and data collection, conducted the data analyses, and wrote the first draft of the manuscript.
Dr. Pechacek conceptualized and designed the study, administered the survey and data collection, conducted the data analyses, and made important intellectual contributions to the development of the first draft.
Dr. Spears and Dr. Ashley conceptualized and designed the study, reviewed the data analyses, and made important intellectual contributions to the development of the first draft.
All authors reviewed, revised, and approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Abstract

Background

Acute childhood nicotine exposures result in clinical presentations ranging from mild illness to death. United States (US) nicotine e-liquid (NEL)-related cases of childhood nicotine toxicity have risen sharply in recent years.

Methods

US adults (≥18 years, *n*=611) were surveyed via Amazon MTurk in April 2018. All participants lived with a child (≤6 years), and either: currently used nicotine-containing electronic vapor products (EVP); were not EVP users, but lived with an adult current EVP user; or lived in a never-EVP using home. Risk perceptions of children's (≤6 years) exposure to five modes (lips, nose, eyes, skin, swallowing) at two NEL doses were elicited. Binomial descriptive and x^2 statistics characterized the sample; multinomial regression analyses examined relationships between respondent characteristics and perceived NEL harm to children.

Results

Non-EVP user respondents characterized NEL exposure as 'moderately' or 'very' dangerous to children across all exposure dose/mode dyads examined. Current users had significantly lower odds of perceiving similar risks in the majority of modes examined; for example, they had significantly lower odds of characterizing a teaspoon or more of NEL as 'very dangerous' (OR_{adj}:0.4; 95%CL:0.1,0.9) in a child's nose, or "moderately dangerous" (OR_{adj}:0.5; 95%CL:0.3,0.9) on a child's skin.

Conclusions

These results raise concern about lack of knowledge of the health risk of children's exposure to NEL; they underscore the need to better understand how these products are used, handled, and stored in the presence of children. Interventions are needed to protect children from NEL exposure and educate users of these products.

Introduction

There has been a proliferation of non-cigarette tobacco products in the United States (US) market over the past decade,[1] providing new sources of nicotine consumption for adults and unintended exposures to children. Ever-use of electronic vapor products (EVP), a type of non-cigarette tobacco product, increased significantly among US adults in recent years.[2] EVPs approximate the smoking experience[3] by aerosolizing liquid suspensions ('e-liquids') that typically contain varying amounts of nicotine, propylene glycol, glycerin, food-grade flavorings and other additives for inhalation.[4] While many smokers view EVPs as smoking cessation aids[5], their efficacy in this regard is unclear.[5-11] The Centers for Disease Control and Prevention estimates that in 2016, 15.4% of US adults had ever used EVPs and 3.2% were current users.[12]

Childhood nicotine toxicity resulting from exposures to nicotine e-liquids (NEL) used in EVPs is of particular concern.[13] NEL were second only to cigarettes as a source of unintended childhood nicotine exposure in the US in recent years.[13,14] While EVPs use may be less harmful for adults versus smoking cigarettes,[15,16] NEL exposure (by ingestion and skin/mucous membrane contact) has been highlighted as a principle reason for the 1500% increase in tobacco product-related calls to the National Poison Data System between 2012 and 2015.[13,17] Children ingesting NEL are five times more likely to require hospitalization and more than twice as likely to have a severe outcome, compared to children ingesting conventional cigarette materials;[13] NEL ingestion has resulted in clinical presentations ranging from acute gastrointestinal illness to convulsions, altered consciousness, and death.[13,18-20] Although the nicotine human oral fatal dose (LD-50) of 60 mg for adults and 10 mg for children are commonly cited, the origins and objective evidence supporting these guidelines are unclear.[21,22]

A 2016 US federal law mandated childproof packaging for NEL,[23] resulting in an approximately 20% decrease in overall reports of NEL exposures to the American Association of

Poison Control Centers' (AAPCC) hotlines following the law's enactment.[24,25] However, several hundred NEL exposures continue to be reported to AAPCC monthly. Calls to AAPCC seeking information regarding identified exposures is a crude measure and likely underestimates the actual number; at present it is the only national exposure tracking metric available in the US.[26]

The persistence of this problem following statutory regulation underscores the need for additional efforts such as: educational interventions to inform EVP users and the people who live with them about the dangers of NEL for children; development of guidelines for safe handling and storage of NEL; and Public Health (PH) messaging about appropriate interventions to manage childhood nicotine exposures. Given the lack of reliable epidemiologic data documenting rates and outcomes associated with nicotine toxicity in humans, a systematic mechanism to track such exposures would be helpful. The latter information is particularly important with the ever- increasing number of sources of nicotine exposure in the public marketplace.

Research documenting adults' risk perceptions regarding young children's exposure to NEL is very limited. The authors of one published study[27] examined some of these issues specifically related to EVPs among parents of child patients in an urban pediatric practice. Although most parents in this study believed that children's ingestion of NEL would be dangerous, less than a third thought skin contact would be dangerous. Many EVP-using parents in that study did not have adequate knowledge about nicotine-specific harms to children, and NEL safe-storage practices were inconsistent.[27] Authors of another published study[28] reported analyses of a nationally representative survey of adults' risk perceptions of children's harm from nicotine exposure generally (not EVP-specific). Results indicated that specific population

subgroups (including current tobacco product users, males, and persons from racial/ethnic minorities) tended to perceive lower harmfulness of nicotine to children.

Because NELs have become an important source of children's exposure to nicotine in recent years, research is needed to assess adults' risk perceptions of NEL causing harm to children, and how perceptions covary with different exposure doses and modes (e.g., swallowing vs. skin contact). Such research should include not only EVP users, but also other adults who live with them and are responsible for providing a safe environment for the children in the home. Thus, the current foundational study sought to: 1) document the risk perceptions of US adult EVP-users and non-users who live in a home with at least one child (≤6 years); and 2) examine whether demographic and/or behavioral factors (e.g., level of education, EVP-use status) are related to perceptions of nicotine harm to children.

Methods

Sample

Data were obtained via an online survey administered on the Amazon Mechanical Turk Platform (MTurk) during April 2 and 3, 2018. MTurk is a crowd-sourcing platform that provides researchers with an efficient, diverse, and easily accessible pool of respondents.[29-32] Samples drawn from MTurk are not demographically representative of the US adult population.[29] During this study's data collection period, the MTurk worker pool demographics were, on average: 56.7% female, 83.3% in a household of four or fewer people, 41.3% married, and 12% cohabiting;[33] information regarding number and ages of children in the households, and the racial/ethnic distribution in the pool were not available.

Eligibility criteria for this study included: aged 18 years and older, current US resident, lives in a home with at least one child (aged ≤6 years), and either: currently uses EVP, lives with another adult current EVP-user, or no adult in the home has ever used EVP. The study protocol

was reviewed by the Georgia State University (GSU) Institutional Review Board and determined to be exempt. Participants were paid $2 for their responses, which were completed in an average of 9 minutes.

Measures

Socio-Demographics

Age ('18-34 years' and '35 years and older'), sex, education ('some college or less' and 'Bachelor's degree or higher'), race/ethnicity ('White non-Hispanic' and 'Black non-Hispanic, Hispanic, or Other'), and relationship to the youngest child ('parent or parent figure' and 'other relative or cohabiting') residing in the home were assessed.

EVP use

Participants were asked about the current use of EVP in their homes. Those who described either themselves or another adult living with them having used EVP in the preceding 30 days or stated that no adult living in their home had ever used EVP were included. Adults who were or lived with an EVP-user were also asked, *"Do the e-liquids that are vaped in electronic vapor products in your home usually contain nicotine?"*; those responding 'yes' or 'I don't know' were included, while those responding 'no' (n = 44) were excluded.

Perceptions of Nicotine-related Harm

With no existing measures to study adults' perceptions of NEL harm to children, we consulted with experts from GSU's National SafeCare Training Center (https://safecare.publichealth.gsu.edu/) and GSU Tobacco Center of Regulatory Sciences (https://tcors.publichealth.gsu.edu/) to inform construction of the survey instrument. To elicit perceptions of NEL harm to children, participants were asked (for example): "*How dangerous do you think it would be for a child (6 years old or younger) to* ***swallow 1 or 2 drops*** *of e-liquid?*"

Versions of this question were asked for two different doses ("*1 or 2 drops"* and *"a teaspoon or more"*) of e-liquid for each of the following exposure types: skin contact, on the lips, inside the nose, in the eye, and swallowing. Response options included: *'very dangerous,' 'moderately dangerous,' 'minimally or not dangerous at all,'* and '*I don't know.*' The '*I don't know*' responses accounted for 1-4% of total responses and were excluded from the analyses.

Measure of Social Desirability

The Social Desirability Response Scale (SDRS)[34] was incorporated into the study survey questionnaire due to the nature of the survey's focus on nicotine harms to children. The SDRS is a brief measure of tendency towards socially desirable responses consisting of five items;[35] it has been evaluated in a number of different settings and cultures and found to have a high degree of reliability and internal consistency.[34,35] The items were scored "1" to "5", with a mean composite score close to 5 representing a tendency towards responding in a socially desirable manner.

Data Analysis

Univariate and bivariate frequencies, chi-squared (x^2) tests, and multinomial logistic regression analyses were performed using SAS software, version 9.4 (©2012, The SAS Institute, Cary, NC). Descriptive statistics and x^2 tests evaluated the demographic characteristics and responses to the NEL harm to children risk perception responses of the total sample and by their EVP use status; patterns of significant associations among the independent variables (IV) and between the IV and dependent variables (DV) were examined using x^2 tests to inform the model building process. Multinomial logistic regression was utilized to examine adjusted relationships between the IVs and DVs.

Results

The univariate demographic and bivariate by EVP-use status frequencies are presented in Table 1. Except for highest level of education completed and categorical age, all demographic

variables were significantly associated with EVP-use status. In addition, EVP-use status was significantly associated with perceptions of child (≤6 years) NEL exposures in all combinations of dose levels and exposure modes. EVP users in this sample were significantly more likely to be male ($p < .0001$).

PLACE TABLE 1 HERE

Results of the multinomial regression models (Tables 2-5, Supplemental Table S1) demonstrated that current EVP users had significantly lower odds (versus adult never-EVP users in never-EVP using homes) of responding that children (<6 years) being exposed to NEL was 'moderately' or 'very' dangerous in seven out of ten of the dose/exposure-mode dyads examined. For example, EVP users had significantly lower odds (versus adults from homes of never-EVP users) of perceiving the following doses/modes of NEL contact as very dangerous to a child (<6 years): **A teaspoon or more**: in the nose (OR_{adj}:0.4; 95%CL: 0.1,0.9); **1 or 2 drops**: on the skin (OR_{adj}:0.5; 95%CL: 0.3,0.9), in the nose (OR_{adj}:0.4; 95%CL: 0.2,0.7), on the lips (OR_{adj}:0.5; 95%CL: 0.2,0.8), and swallowed (OR_{adj}:0.5; 95%CL: 0.3,1.0). The only dose/exposure-mode dyads in which none of the current EVP users' perceptions of nicotine harm to children (≤6 years) differed significantly from those of adults from never EVP-use homes was in both doses of eye contact (Supplemental Table S1).

PLACE TABLE 2 HERE

PLACE TABLE 3 HERE

PLACE TABLE 4 HERE

PLACE TABLE 5 HERE

In addition, males had significantly lower odds (versus females) of perceiving NEL exposure by swallowing 1 or 2 drops (Table 5) as "very dangerous" to children (<6 years), and a

teaspoon or more of NEL exposure on the skin (Table 4) as "very dangerous" to children (<6 years). Adults 34 years old and younger had significantly lower odds (versus adults 35 years old and older) of perceiving a teaspoon or more of NEL in the nose contact as being "moderately dangerous" or "very dangerous" (Table 3), and perceiving skin contact exposure of a teaspoon or more of NEL as "very dangerous" to children 6 years and younger (Table 4).

The sample composite mean SDRS score of 1.08 (95%CL: 0.97,1.18) indicated a lack of tendency towards responding in a socially desirable (rather than objective) manner among the sample.

Discussion

This study analyzed US adults' perceptions of different doses and modes of NEL exposures being dangerous to children (<6 years) in a sample of US adults who were either current EVP-users, non-users who lived with a current EVP-user, or never-users living in a household of never-EVP users. Findings indicate that while the majority perceived all NEL exposure dose/mode dyads as "moderately" or "very" dangerous to children, current EVP users had significantly lower odds of endorsing such perceived harm in the majority of doses/mode dyads examined. This study also found that males and younger adults had significantly lower odds of perceiving some NEL exposure dose/mode dyads as being "moderately" or "very" dangerous to a child (≤6 years). Interestingly, adult non-users living with an EVP-user demonstrated patterns of responses very similar to adult never-EVP users living in never EVP-using homes.

The findings that EVP users had lower odds of perceiving NEL exposure as being moderately or very dangerous to children (<6 years) in the majority of dose/mode dyads examined are a particular cause for concern, given that (presumably) EVP users have the most control over the source of NEL exposure in the home. EVP use has grown among current and

former smokers, as well as those who have never smoked cigarettes in the US.[2,36] This trend is expected to continue as more of these products are developed and marketed[37] and national policies are enacted to continue downward pressure on smoking rates, leaving smokers to consume nicotine by alternative means such as EVPs.[38,39]

While EVPs might provide a less harmful alternative to smokers under certain circumstances,[40] they have become a leading source of harmful nicotine exposure to children.[13,14,18,25] Many of the food-grade fruit and candy flavors used in NEL are appealing to children,[41,42] and the products are marketed in a way that primarily promotes their flavors.[41-45] Furthermore, the packaging of some NELs emphasize fruit or candy flavors and can closely resemble popular branded candy packages[46] (for example, see Figure 1[47]), leading the FDA (in conjunction with the Federal Trade Commission) to issue warning letters to a number of NEL manufacturers in 2018.[48]

PLACE FIGURE 1 HERE

The number of cases of nicotine poisonings resulting from child exposures to NEL has risen sharply in recent years.[13,49] Although there was a 20% reduction in the number of reported NEL exposures after national mandates for childproof packaging became effective in July 2016, several hundred such exposures continue to be reported monthly in the US.[49] While AAPCC data provide some indication that nicotine exposures are occurring, more precise and accurate epidemiologic data are needed to appreciate the true scope of this problem.

Our findings are similar to those of Garbutt et al.,[27] who reported finding variations in adults' perceptions of risks of children being exposed to NEL by mode of exposure. However, their study did not examine doses of exposure. The findings of the present study also build on those of Kemp et al.,[28] who reported that although adults generally (not specific to a product or

mode of exposure) perceived child (< 13 years) exposure to nicotine as very harmful, current tobacco product users (including EVP users), non-Hispanic African American individuals, Hispanic individuals, and males had significantly lower odds of perceiving such harm. In the current study, we similarly found that current EVP users and males had lower odds of perceiving NEL exposures as "moderately" or "very" dangerous to children (<6 years); we did not have similar findings based on racial/ethnic minority status. Thus, this study examining adults' perceptions of nicotine harms to children (<6 years) at different doses and modes of exposure and controlling for EVP-use in the home status, is the first (to our knowledge) of its kind. This study provides important evidence of variations in risk perceptions among EVP users and adults who live with them, some younger adults, and some males that may contribute to the risks of children's exposure to NEL, and subsequent harm.

Although this study's restricted sampling frame (MTurk) limits the generalizability of its findings, the consistency with which EVP users estimated less danger (versus EVP non-users) to children (<6 years) from being exposed to different doses and modes of NEL suggests that these findings could be replicated in a more general sample. Individuals from racial/ethnic minority populations were underrepresented in our sample, a limitation of the MTurk sampling frame that has been cited by other authors;[30,32] this may have limited our study's ability to detect differences in adults' risk perceptions by race/ethnicity. At a minimum, these results indicate that further research in a more general sample of adult EVP users is needed to investigate how and why adults' perceptions of NEL harm to children vary. Research as to what actions are indicated to better protect children from this exposure will be important as well.

This study was also limited by the lack of validated measures available to study adults' perceptions of NEL harm to children. We attempted to address this limitation by drawing on the

expertise of Tobacco Control and Child Safety experts when constructing the survey questions and including different doses and modes of exposure.

This is one of the first studies examining aspects of adults' perceptions of the risks that nicotine exposure poses to children, in relation to demographic and/or EVP use characteristics. The current findings provide important evidence of a need not only for further research, but also for policy interventions and guidance for adults from EVP-using homes about the dangers of children's exposure to NEL. Pediatric care providers may be able to play an important role in protecting children from NEL exposures and related harms by identifying those at risk and educating the adults who live with them. Retailers could also be a valuable source to warn adult users about the danger of leaving EVP liquids accessible to small children. While national NEL-specific storage and handling guidelines have yet to be developed, measures such as ensuring that containers have child-proof packaging, and handling and storing the materials in a secure place out of children's reach will likely be helpful in preventing such exposures and subsequent harm to children.

Conclusion

Exposure to nicotine during critical child development periods has been associated with a range of acute[13,25,50,51] and chronic[52,53] adverse clinical outcomes. NEL used in EVPs have become a significant source, second only to cigarettes,[24] of children being exposed to nicotine in the US. Adults' knowledge and perceptions of the risks posed to children by NEL exposure has received scant attention in the literature. This study's findings, that EVP users who live with a child (<6 years) have significantly lower odds of characterizing NEL exposures as being moderately or very dangerous to children across different doses and modes, is a cause for concern. This finding provides important evidence for clinicians, policy-makers, and the Tobacco Regulatory Science community. Further research of harm perceptions related to

children's exposure to NEL, and how those alter the way products are managed in the presence of children, is needed to identify factors that put children at risk. Actions are needed to improve safe NEL handling in homes were children are present.

References

1. Kasza KA, Ambrose BK, Conway KP, et al. Tobacco-Product Use by Adults and Youths in the United States in 2013 and 2014. *New England Journal of Medicine.* 2017;376(4):342-353.
2. Bao W, Xu G, Lu J, Snetselaar LG, Wallace RB. Changes in electronic cigarette use among adults in the united states, 2014-2016. *JAMA.* 2018;319(19):2039-2041.
3. Walele T, Sharma G, Savioz R, Martin C, Williams J. A randomised, crossover study on an electronic vapour product, a nicotine inhalator and a conventional cigarette. Part A: Pharmacokinetics. *Regulatory Toxicology and Pharmacology.* 2016;74:187-192.
4. Fearon IM, Eldridge A, Gale N, et al. E-cigarette Nicotine Delivery: Data and Learnings from Pharmacokinetic Studies. *American Journal of Health Behavior.* 2017;41(1):16-32.
5. Vickerman KA, Beebe LA, Schauer GL, Magnusson B, King BA. Electronic nicotine delivery system (ENDS) use during smoking cessation: a qualitative study of 40 Oklahoma quitline callers. *BMJ open.* 2017;7(4).
6. Thrul J, Ramo DE. Cessation strategies young adult smokers use after participating in a Facebook intervention. *Substance Use & Misuse.* 2017;52(2):259-264.
7. Levy DT, Zhe Y, Luo Y. The relationship of e-cigarette use to cigarette quit attempts and cessation: Insights from a large, nationally representative U.S. survey. *Nic Tob Res.* 2017;ntx166.
8. El Dib R, Suzumura EA, Akl EA, et al. Electronic nicotine delivery systems and/or electronic non-nicotine delivery systems for tobacco smoking cessation or reduction: a systematic review and meta-analysis. *BMJ open.* 2017;7(2).
9. West R, Shahab L, Brown J. Estimating the population impact of e-cigarettes on smoking cessation in England. *Addiction (Abingdon, England).* 2016;111(6):1118-1119.
10. McRobbie H, Bullen C, Hartmann-Boyce J, Hajek P. Electronic cigarettes for smoking cessation and reduction. *The Cochrane Database Of Systematic Reviews.* 2014(12):CD010216.
11. Hartmann-Boyce J, McRobbie H, Bullen C, Begh R, Stead LF, Hajek P. Electronic cigarettes for smoking cessation. *Cochrane Database of Systematic Reviews.* 2016(9).
12. QuickStats: Percentage of Adults Who Ever Used an E-cigarette and Percentage Who Currently Use E-cigarettes, by Age Group — National Health Interview Survey, United States, 2016. *MMWR Morb Mortal Wkly Rep.* 2017;66:892.
13. Kamboj A, Spiller HA, Casavant MJ, Chounthirath T, Smith GA. Pediatric Exposure to E-Cigarettes, Nicotine, and Tobacco Products in the United States. *Pediatrics.* 2016;137(6).
14. Wang B, Rostron B. Tobacco-related Poison Events Involving Young Children in the US, 2001-2016. *Tobacco Regulatory Science.* 2017;3(4):525-535.
15. Grana R, Benowitz N, Glantz SA. E-Cigarettes: A Scientific Review. *Circulation.* 2014;129(19):1972-1986.
16. Farsalinos KE, Polosa R. Safety evaluation and risk assessment of electronic cigarettes as tobacco cigarette substitutes: a systematic review. *Ther Adv Drug Saf.* 2014;5(2):67-86.
17. Jo CL, Ambs A, Dresler CM, Backinger CL. Review Article: Child-resistant and tamper-resistant packaging: A systematic review to inform tobacco packaging regulation. *Preventive Medicine.* 2017;95:89-95.

18. Chatham-Stephens K, Law R, Taylor E, et al. Calls to Poison Centers for Exposures to Electronic Cigarettes -- United States, September 2010-February 2014. *MMWR Morb Mortal Wkly Rep.* 2014;63(13):292-293.
19. Vakkalanka JP, Hardison LS, Holstege CP. Epidemiological trends in electronic cigarette exposures reported to U.S. Poison Centers. *Clinical Toxicology (15563650).* 2014;52(5):542-548.
20. Noble MJ, Longstreet B, Hendrickson RG, Gerona R. Toxicology/Case report: Unintentional Pediatric Ingestion of Electronic Cigarette Nicotine Refill Liquid Necessitating Intubation. *Annals of Emergency Medicine.* 2016.
21. Nicotine. In: Samet JM, Pechacek TF, eds. *The Health Consequences of Smoking: 50 Years of Progress. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014:107-139.
22. Mayer B. How much nicotine kills a human? Tracing back the generally accepted lethal dose to dubious self-experiments in the nineteenth century. *Archives of Toxicology.* 2014;88(1):5-7.
23. Nelson B. Child Nicotine Poisoning Prevention Act of 2015. In: America tCotUSo, ed. *Pub.L. 114-116.* Vol 15 USC 1471. Washington, D.C.: United States Congress; 2016:3.
24. *Electronic Cigarettes and Liquid Nicotine Data.* Alexandria, VA: American Association of Poison Control Centers; February 28 2018.
25. Govindarajan P, Spiller HA, Casavant MJ, Chounthirath T, Smith GA. E-Cigarette and Liquid Nicotine Exposures Among Young Children. LID - e20173361 [pii] LID - 10.1542/peds.2017-3361 [doi]. (1098-4275 (Electronic)).
26. Gummin DD, Mowry JB, Spyker DA, Brooks DE, Fraser MO, Banner W. 2016 Annual Report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 34th Annual Report. (1556-9519 (Electronic)).
27. Garbutt JM, Miller W, Dodd S, Bobenhouse N, Sterkel R, Strunk RC. Parental Use of Electronic Cigarettes. *Academic Pediatrics.* 2015;15(6):599-604.
28. Kemp CB, Spears CA, Pechacek TF, Eriksen MP. Adults' Perceptions of Nicotine Harm to Children. *Pediatrics.* 2018;142(2).
29. Sheehan KB. Crowdsourcing research: Data collection with Amazon's Mechanical Turk. *Commun Monogr.* 2018;85(1):140-156.
30. Berinsky AJ, Huber GA, Lenz GS. Evaluating Online Labor Markets for Experimental Research: Amazon.com's Mechanical Turk. *Political Analysis.* 2012;20(3):351.
31. Mason W, Suri S. Conducting behavioral research on Amazon's Mechanical Turk. *BEHAVIOR RESEARCH METHODS.* 2012;44(1):1-23.
32. Bardos J, Friedenthal J, Spiegelman J, Williams Z. Cloud Based Surveys to Assess Patient Perceptions of Health Care: 1000 Respondents in 3 days for US $300. *JMIR Research Protocols.* 2016;5(3):e166.
33. Ipeirotis P. Demographics. *mturk tracker* 2018; http://demographics.mturk-tracker.com. Accessed May 12, 2018.
34. Hays R, Hayashi T, Stewart A. *A Five-Item Measure of Socially Desirable Response Set.* Vol 491989.
35. Socially Desirable Response Set Five-Item Survey (SDRS-5). *Rand Corporation* https://www.rand.org/health/surveys_tools/sdrs.html. Accessed Feb. 2, 2018.

36. Owusu D, Huang J, Weaver S, Pechacek T, Nayak P, Eriksen M. Pattern and Trend of Dual Use of E-cigarettes and Cigarettes among U.S. Adults, 2014 – 2017. *Manuscript in development.* 2018.
37. Herzog B, Kanada P. *Nielsen: Tobacco 'All Channel' Data 1/27.* New York, NY: Wells Fargo Securities; Feb. 6 2018.
38. Gottlieb S, Zeller M. A Nicotine-Focused Framework for Public Health. *New England Journal of Medicine.* 2017;377(12):1111-1114.
39. Statement from FDA Commissioner Scott Gottlieb, M.D., on pivotal public health step to dramatically reduce smoking rates by lowering nicotine in combustible cigarettes to minimally or non-addictive levels [press release]. Silver Springs, MD: U.S. Food & Drug Administration2018.
40. National Academies of Sciences E, Medicine. *Public Health Consequences of E-Cigarettes.* Washington, DC: The National Academies Press; 2018.
41. Kong G, Morean ME, Cavallo DA, Camenga DR, Krishnan-Sarin S. Reasons for electronic cigarette experimentation and discontinuation among adolescents and young adults. *Nicotine & Tobacco Research.* 2015;17(7):847-854.
42. Morean ME, Butler ER, Bold KW, et al. Preferring more e-cigarette flavors is associated with e-cigarette use frequency among adolescents but not adults. *PLoS ONE.* 2018;13(1):1-10.
43. Zhu S-H, Sun JY, Bonnevie E, et al. Four hundred and sixty brands of e-cigarettes and counting: Implications for product regulation. *Tobacco Control: An International Journal.* 2014;23(Supp 3):3-9.
44. Pepper JK, Ribisl KM, Brewer NT. Adolescents' interest in trying flavoured e-cigarettes. *Tobacco Control.* 2016.
45. FDA, FTC take action against companies misleading kids with e-liquids that resemble children's juice boxes, candies and cookies [press release]. Washington, D.C.: Food and Drug Administration, May 1 2018.
46. FDA-CTP. E-Liquids Misleadingly Labeled or Advertised as Food Products. 2018; https://www.fda.gov/TobaccoProducts/NewsEvents/ucm605729.htm. Accessed May 22, 2018.
47. Simoneau A, Engle MK. Warning Letters- Drip More LCC 5/1/18. 2018; https://www.fda.gov/ICECI/EnforcementActions/WarningLetters/ucm605938.htm. Accessed May 22, 2018.
48. FDA, FTC take action against companies misleading kids with e-liquids that resemble children's juice boxes, candies and cookies. 2018; https://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm605507.htm. Accessed May 22, 2018.
49. *Electronic Cigarettes and Liquid Nicotine Data.* Alexandria, VA: American Association of Poison Control Centers; January 31 2017.
50. Quan D, Kuehnle SE. Electronic Cigarette and Nicotine Toxicity. *Primary Care Reports.* 2016;22(2):13-23.
51. Hua M, Talbot P. Review Article: Potential health effects of electronic cigarettes: A systematic review of case reports. *Preventive Medicine Reports.* 2016;4:169-178.
52. Dwyer JB, McQuown SC, Leslie FM. The Dynamic Effects of Nicotine on the Developing Brain. *Pharmacology & therapeutics.* 2009;122(2):125-139.

53. England LJ, Bunnell RE, Pechacek TF, Tong VT, McAfee TA. Nicotine and the Developing Human. A Neglected Element in the Electronic Cigarette Debate. *American Journal of Preventive Medicine.* 2015.

Table 1. Univariate and bivariate analyses of sample demographics and risk perceptions of children (< 6 years old) being exposed to nicotine e-liquids at different doses and by different modes stratified by EVP use status (N = 611).

	Univariate	Bivariate By EVP_USE variable			
	% (95% CL^)	**EVP user % (95% CL)**	**Never-user, lives w/EVP user % (95% CL)**	**Never EVP-use by any adult in home % (95% CL)**	**(x^2, *df*), p-value**
EVP use status	611 (100)	**41.9 (38.0, 45.8)***	29.0 (25.4, 32.6)	29.1 (25.5, 32.7)	(20.2, 2) <.0001
Relationship with youngest child in the home					(8.6, 2) .01
Parent or parent figure	78.4 (75.1, 81.7)	75.8 (70.5, 81.0)	74.6 (68.1, 81.0)	86.0 (80.8, 91.2)	
Other relative or roommate of parent	21.6 (18.3, 24.9)	24.2 (19.0, 29.5)	25.4 (19.0, 31.9)	14.0 (8.9, 19.2)	
Sex					(24.8, 2) <.0001
Male	47.1 (43.2, 51.1)	**59.0 (52.9, 65.0)***	38.4 (31.2, 45.6)	38.8 (31.6, 45.9)	
Female	52.9 (48.9, 56.8)	**41.0 (35.0, 47.1)***	61.6 (54.4, 68.8)	61.2 (54.1, 68.4)	
Race/Ethnicity					(5.8, 2) .05
White, NH	80.5 (77.4, 83.7)	78.5 (74.5, 83.6)	77.4 (71.2, 83.6)	86.5 (81.5, 91.5)	
African-American, Hispanic, or Other	19.5 (16.3, 22.6)	21.5 (16.4, 26.5)	22.6 (16.4, 28.8)	13.5 (8.5, 18.5)	
Categorical Age (Continuous-μ = 35.6, σ = 8.5)					(.19, 2) .90
18-34	52.9 (48.9, 56.8)	52.3 (46.2, 58.5)	54.2 (46.9, 61.6)	52.2 (44.9, 59.6)	
≥ 35	47.1 (43.2, 51.1)	47.7 (41.5, 53.8)	45.8 (38.4, 53.1)	47.8 (40.4, 55.1)	
Highest education completed					(3.8, 2) .15
<=Some college	29.8 (26.1, 33.4)	34.0 (28.2, 39.8)	26.3 (19.7, 32.8)	27.1 (20.6, 33.7)	
>= Bachelor's	70.2 (66.6, 73.9)	66.0 (60.2, 81.8)	73.7 (67.2, 80.3)	72.9 (66.3, 79.4)	
Perceptions of nicotine e-liquid harm to children by…					
On the lips…					
…1 or 2 drops					(21.5, 4) .0003
Very dangerous	43.0 (39.0, 46.9)	**35.8 (29.9, 41.7)***	51.4 (44.0, 58.9)	44.8 (37.4, 52.2)	
Moderately dangerous	36.0 (32.1, 39.8)	35.0 (29.2, 40.9)	32.6 (25.6, 39.5)	40.8 (33.5, 48.1)	
Minimally or not dangerous at all	21.1 (17.8, 24.3)	**29.1 (23.5, 34.7)***	16.0 (10.6, 21.4)	14.4 (9.1, 19.6)	
…A teaspoonful or more					(25.6, 4) <.0001
Very dangerous	61.6 (57.7, 65.5)	**57.2 (46.0, 58.4)***	68.6 (61.7, 75.5)	68.0 (61.1, 74.9)	
Moderately dangerous	29.1 (25.5, 32.8)	32.7 (26.5, 38.1)	26.3 (19.7, 32.8)	27.4 (20.8, 34.1)	
Minimally or not dangerous at all	9.3 (7.0, 11.6)	**15.5 (11.0, 20.0)***	5.1 (1.9, 8.4)	4.6 (1.5, 7.7)	
In the nose …					
…1 or 2 drops					(24.7, 4) <.0001
Very dangerous	45.3 (41.3, 49.3)	34.9 (29.0, 40.8)	**57.7 (50.4, 65.1)***	48.0 (40.5, 55.4)	
Moderately dangerous	37.1 (33.3, 41.1)	40.8 (34.7, 46.8)	29.1 (22.4, 35.9)	39.9 (32.6, 47.2)	
Minimally or not dangerous at all	17.2 (14.5, 20.6)	**24.3 (19.0, 29.6)***	13.1 (8.1, 18.2)	12.1 (7.3, 17.1)	
…A teaspoonful or more					(24.3, 4) <.0001
Very dangerous	65.8 (62.0, 69.6)	58.0 (52.0, 64.1)	72.0 (65.3, 78.7)	70.9 (64.1, 77.6)	
Moderately dangerous	25.1 (21.7, 28.6)	27.5 (22.0, 32.9)	24.0 (17.7, 30.3)	22.9 (16.6, 29.1)	
Minimally or not dangerous at all	9.1 (6.8, 11.4)	**14.5 (10.2, 18.8)***	4.0 (1.1, 6.9)	6.3 (2.7, 9.9)	
In the eye…					
…1 or 2 drops					(24.7, 4) <.0001
Very dangerous	69.8 (66.1, 73.5)	63.1 (57.2, 69.1)	73.9 (67.4, 80.4)	75.4 (69.0, 81.8)	
Moderately dangerous	23.9 (20.5, 27.3)	27.8 (22.3, 33.4)	21.0 (15.0, 27.1)	21.1 (15.1, 27.2)	
Minimally or not dangerous at all	6.3 (4.3, 8.2)	9.0 (5.5, 12.5)	5.1 (1.9, 8.4)	3.4 (0.7, 6.1)	
…A teaspoonful or more					(11.9, 4) .02
Very dangerous	81.3 (78.2, 84.4)	**76.4 (71.1, 81.6)***	83.0 (77.4, 88.5)	86.9 (81.8, 91.9)	
Moderately dangerous	14.7 (11.9, 17.5)	16.9 (12.3, 21.6)	14.8 (9.5, 20.0)	11.4 (6.7, 16.2)	
Minimally or not dangerous at all	4.0 (2.4, 5.5)	**6.7 (3.6, 9.8)***	2.3 (0.1, 4.5)	1.7 (0.0, 3.6)	
On the skin…					
…1 or 2 drops					(14.9, 4) .005
Very dangerous	19.3 (16.1, 22.4)	14.2 (9.8, 18.5)	22.9 (16.6, 29.3)	22.9 (16.6, 29.3)	
Moderately dangerous	38.0 (34.1, 41.9)	34.4 (28.5, 40.4)	39.4 (32.0, 46.8)	41.8 (34.3, 49.2)	
Minimally or not dangerous at all	42.8 (38.7, 46.8)	**51.4 (45.2, 57.7)***	37.6 (30.3, 45.0)	35.3 (28.1, 42.5)	
…A teaspoonful or more					(15.5, 4) .004
Very dangerous	36.4 (32.5, 40.3)	30.9 (25.1, 36.7)	42.8 (35.4, 50.2)	38.0 (30.7, 45.3)	
Moderately dangerous	36.4 (32.5, 40.3)	34.1 (28.2, 40.1)	34.7 (27.6, 41.8)	41.5 (34.1, 48.9)	
Minimally or not dangerous at all	27.1 (23.5, 30.7)	**35.0 (29.0, 40.9)***	22.5 (16.3, 28.8)	20.5 (14.4, 26.5)	
Swallowing…					
…1 or 2 drops					(16.5, 4) .003
Very dangerous	56.9 (52.9, 60.8)	**47.4 (41.3, 53.6)***	64.6 (57.5, 71.7)	62.9 (55.7, 70.0)	
Moderately dangerous	28.7 (25.1, 32.3)	34.0 (28.1, 39.8)	24.0 (17.7, 30.3)	25.7 (19.2, 32.2)	
Minimally or not dangerous at all	14.4 (11.6, 17.2)	18.6 (13.8, 23.4)	11.4 (6.7, 16.2)	11.4 (6.7, 16.2)	
…A teaspoonful or more					(12.2, 4) .02
Very dangerous	76.9 (73.5, 80.2)	**71.1 (65.5, 76.7)***	79.5 (73.6, 85.5)	82.4 (76.7, 88.0)	
Moderately dangerous	19.7 (16.5, 22.8)	22.9 (17.7, 28.1)	18.8 (13.0, 24.5)	15.9 (10.5, 21.3)	
Minimally or not dangerous at all	3.5 (2.0, 4.9)	**5.9 (3.0, 8.8)***	1.7 (0, 3.6)	1.7 (0.0, 3.6)	

Abbreviations: ^CL: confidence limits.
*Indicates statistically significantly different from the reference category, 'Never EVP-use by any adult in home'

Table 2. Multinomial logistic regression models regressing demographic and EVP-use characteristics on adult's perceptions of 2 different doses of EVP e-liquid nicotine on the lips causing harm to a child 6 years and younger.

	Model 2.1, On the lips contact with 2 or 3 drops of nicotine e-liquid[1,2]		**Model 2.2, On the lips contact with a teaspoon or more of nicotine e-liquid[1,2]**	
	Moderately Dangerous	**Very Dangerous**	**Moderately Dangerous**	**Very Dangerous**
	OR[¥] (95% CL[^])	**OR[¥] (95% CL[^])**	**OR[¥] (95% CL[^])**	**OR[¥] (95% CL[^])**
Global test of *null* hypothesis [$F_{(df)}$; p]	$1.8_{(14,543)}$; .04		$2.7_{(14,543)}$; .0008	
EVP use status				
EVP user	**0.5 (0.3, 0.9)***	**0.5 (0.2, 0.8)***	**0.3 (0.1, 0.7)***	0.4 (0.2, 1.1)
Never-user, lives w/EVP user	0.6 (0.3, 1.3)	0.9 (0.5, 1.8)	1.0 (0.3, 3.0)	0.9 (0.3, 2.8)
Never EVP-use by any adult in home	*ref*	*ref*	*ref*	*ref*
Relationship with youngest child in the home				
Parent or parent figure	1.1 (0.6, 1.9)	1.4 (0.8, 2.5)	1.1 (0.5, 2.5)	1.1 (0.5, 2.5)
Other relative or roommate of parent	*ref*	*ref*	*ref*	*ref*
Sex				
Male	0.7 (0.4, 1.1)	**0.6 (0.4, 1.0)***	**0.3 (0.2, 0.7)***	**0.3 (0.2, 0.7)***
Female	*ref*	*ref*	*ref*	*ref*
Categorical Age				
18-34	1.0 (0.6, 1.6)	0.8 (0.5, 1.3)	0.9 (0.5, 1.9)	0.7 (0.3, 1.3)
≥ 35	*ref*	*ref*	*ref*	*ref*

Abbreviations: [¥]OR: odds ratio; [^]CL: confidence limits.

Indicates statistically significantly different from the reference category

*[1] The dependent variable (DV) was assessed with the question: 'How dangerous do you think it would be for a child (6 years old or younger) if [1 or 2 drops; a teaspoon or more] of e-liquid got **on their lips**?' The reference category for the DV is 'Not or minimally dangerous'.*

[2]We adjusted for race/ethnicity and highest education completed in these models. Neither of these variables was significantly associated with the dependent variables in any of the models examined, and therefore are not included in the results table.

Table 3. Multinomial logistic regression models regressing demographic and EVP-use characteristics on adult's perceptions of 2 different doses of EVP e-liquid nicotine in the nose causing harm to a child 6 years and younger.

	Model 3.1, In the nose contact with 2 or 3 drops of nicotine e-liquid[1,2]		**Model 3.2, In the nose contact with a teaspoon or more of nicotine e-liquid[1,2]**	
	Moderately Dangerous	**Very Dangerous**	**Moderately Dangerous**	**Very Dangerous**
	OR[¥] (95% CL[^])	**OR[¥] (95% CL[^])**	**OR[¥] (95% CL[^])**	**OR[¥] (95% CL[^])**
Global test of *null* hypothesis [$F_{(df)}$; p]	$2.9_{(14,543)}$; .0004		$2.7_{(14,543)}$; .0009	
EVP use status				
EVP user	**0.5 (0.2, 0.9)***	**0.4 (0.2, 0.7)***	0.5 (0.2, 1.3)	**0.4 (0.1, 0.9)***
Never-user, lives w/EVP user	0.6 (0.3, 1.3)	1.0 (0.5, 2.1)	1.3 (0.4, 4.5)	1.3 (0.4, 4.0)
Never EVP-use by any adult in home	*ref*	*ref*	*ref*	*ref*
Relationship with youngest child in the home				
Parent or parent figure	1.4 (0.8, 2.5)	1.2 (0.6, 2.1)	0.7 (0.3, 1.7)	0.7 (0.3, 1.7)
Other relative or roommate of parent	*ref*	*ref*	*ref*	*ref*
Sex				
Male	1.2 (0.7, 2.0)	0.7 (0.4, 1.2)	**0.3 (0.1, 0.7)***	**0.2 (0.1, 0.5)***
Female	*ref*	*ref*	*ref*	*ref*
Categorical Age				
18-34	1.0 (0.6, 1.6)	0.7 (0.4, 1.2)	**0.3 (0.2, 0.7)***	**0.3 (0.2, 0.7)***
≥ 35	*ref*	*ref*	*ref*	*ref*

Abbreviations: [¥]OR: odds ratio; [^]CL: confidence limits.
*****Indicates statistically significantly different from the reference category
[1] The dependent variable (DV) was assessed with the question: *'How dangerous do you think it would be for a child (6 years old or younger) if [1 or 2 drops; a teaspoon or more] of e-liquid got **in their nose**?'* The reference category for the DV is *'Not or minimally dangerous'*.
[2]We adjusted for race/ethnicity and highest education completed in these models. Neither of these variables was significantly associated with the dependent variables in any of the models examined, and therefore are not included in the results table.

Table 4. Multinomial logistic regression models regressing demographic and EVP-use characteristics on adult's perceptions of 2 different doses of EVP e-liquid nicotine on the skin causing harm to a child 6 years and younger.

	Model 4.1, Skin contact with 2 or 3 drops of nicotine e-liquid[1,2]		Model 4.2, Skin contact with a teaspoon or more of nicotine e-liquid[1,2]	
	Moderately Dangerous	**Very Dangerous**	**Moderately Dangerous**	**Very Dangerous**
	OR¥ (95% CL^)	**OR¥ (95% CL^)**	**OR¥ (95% CL^)**	**OR¥ (95% CL^)**
Global test of *null* hypothesis [$F_{(df)}$; p]	$2.2_{(14,556)}$; .007		$2.0_{(14,556)}$; .02	
EVP use status				
EVP user	**0.6 (0.4, 1.0)***	**0.5 (0.3, 0.9)***	**0.5 (0.3, 0.9)***	0.6 (0.3, 1.0)
Never-user, lives w/EVP user	1.0 (0.6, 1.6)	1.0 (0.6, 1.9)	0.7 (0.4, 1.4)	1.2 (0.6, 2.1)
Never EVP-use by any adult in home	*ref*	*ref*	*ref*	*ref*
Relationship with youngest child in the home				
Parent or parent figure	**2.3 (1.4, 3.9)***	1.3 (0.7, 2.2)	1.4 (0.8, 2.3)	1.5 (0.9, 2.5)
Other relative or roommate of parent	*ref*	*ref*	*ref*	*ref*
Sex				
Male	1.0 (0.7, 1.5)	0.6 (0.4, 1.0)	0.8 (0.5, 1.2)	**0.6 (0.4, 0.9)***
Female	*ref*	*ref*	*ref*	*ref*
Categorical Age				
18-34	1.0 (0.7, 1.5)	0.7 (0.4, 1.2)	1.0 (0.7, 1.6)	**0.6 (0.4, 1.0)***
≥ 35	*ref*	*ref*	*ref*	*ref*

Abbreviations: ¥OR: odds ratio; ^CL: confidence limits.

*Indicates statistically significantly different from the reference category

[1] The dependent variable (DV) was assessed with the question: *'How dangerous do you think **skin contact** with [1 or 2 drops; a teaspoon or more] of e-liquid is for a child (6 years old or younger)*?' The reference category for the DV is *'Not or minimally dangerous'*.

[2] We adjusted for race/ethnicity and highest education completed in these models. Neither of these variables was significantly associated with the dependent variables in any of the models examined, and therefore are not included in the results table.

Table 5. Multinomial logistic regression models regressing demographic and EVP-use characteristics on adult's perceptions of swallowing 2 different doses of EVP e-liquid nicotine causing harm to a child 6 years and younger.

	Model 5.1, Swallowing 2 or 3 drops of nicotine e-liquid[1,2]		**Model 5.2, Swallowing a teaspoon or more of nicotine e-liquid[1,2]**	
	Moderately Dangerous	**Very Dangerous**	**Moderately Dangerous**	**Very Dangerous**
	OR[¥] (95% CL[^])*	**OR[¥] (95% CL[^])***	**OR[¥] (95% CL[^])***	**OR[¥] (95% CL[^])***
Global test of *null* hypothesis [$F_{(df)}$; p]	$2.6_{(14,556)}$; .001		$2.4_{(14,556)}$; .002	
EVP use status				
EVP user	0.8 (0.4, 1.8)	**0.5 (0.3, 1.0)***	0.5 (0.1, 2.5)	0.2 (0.1, 1.3)
Never-user, lives w/EVP user	0.9 (0.4, 2.0)	1.0 (0.5, 2.1)	1.3 (0.2, 9.8)	1.0 (0.1, 6.9)
Never EVP-use by any adult in home	*ref*	*ref*	*ref*	*ref*
Relationship with youngest child in the home				
Parent or parent figure	0.8 (0.4, 1.6)	1.6 (0.8, 3.0)	0.6 (0.1, 2.5)	0.7 (0.2, 3.1)
Other relative or roommate of parent	*ref*	*ref*	*ref*	*ref*
Sex				
Male	0.9 (0.5, 1.6)	**0.6 (0.3, 1.0)***	0.6 (0.2, 2.1)	0.4 (0.1, 1.5)
Female	*ref*	*ref*	*ref*	*ref*
Categorical Age				
18-34	0.7 (0.4, 1.3)	0.7 (0.4, 1.2)	0.9 (0.3, 2.7)	0.6 (0.2, 1.6)
≥ 35	*ref*	*ref*	*ref*	*ref*

Abbreviations: [¥]OR: odds ratio; [^]CL: confidence limits.

*Indicates statistically significantly different from the reference category

[1] The dependent variable (DV) was assessed with the question: *'How dangerous do you think it would be for a child (6 years old or younger) if they swallowed [1 or 2 drops; a teaspoon or more] of e-liquid?*' The reference category for the DV is *'Not or minimally dangerous'*.

[2]We adjusted for race/ethnicity and highest education completed in these models. Neither of these variables was significantly associated with the dependent variables in any of the models examined, and therefore are not included in the results table.

Figure 1. Nicotine e-liquid packaging (Exhibit A) and similar candy packaging (Exhibit B) cited in an FDA warning letter to the e-liquid manufacturer DripMore LLC, as being labelled and/or advertised in a way that is appealing to children and targeting child consumers. (downloaded 05/22/2018 from: https://www.fda.gov/ICECI/EnforcementActions/WarningLetters/ucm605938.htm)
Jpeg file of this image has been uploaded with the manuscript.

Exhibit A

Exhibit B

Table S1. Multinomial logistic regression models regressing demographic and EVP-use characteristics on adult's perceptions of 2 different doses of EVP e-liquid nicotine in the eye causing harm to a child 6 years and younger.

	Model S1.1, In the eye contact with 2 or 3 drops of nicotine e-liquid[1,2]		**Model S1.2, In the eye contact with a teaspoon or more of nicotine e-liquid[1,2]**	
	Moderately Dangerous	**Very Dangerous**	**Moderately Dangerous**	**Very Dangerous**
	OR[¥] (95% CL[^])	**OR[¥] (95% CL[^])**	**OR[¥] (95% CL[^])**	**OR[¥] (95% CL[^])**
Global test of *null* hypothesis [$F_{(df)}$; *p*]	$1.3_{(14,543)}$; .24		$1.3_{(14,543)}$; .19	
EVP use status				
EVP user	0.6 (0.2, 1.9)	0.4 (0.2, 1.2)	0.4 (0.1, 1.9)	0.3 (0.1, 1.0)
Never-user, lives w/EVP user	1.1 (0.3, 4.0)	1.0 (0.3, 3.4)	2.5 (0.4, 15.5)	1.6 (0.3, 9.2)
Never EVP-use by any adult in home	*ref*	*ref*	*ref*	*ref*
Relationship with youngest child in the home				
Parent or parent figure	0.9 (0.3, 2.5)	1.1 (0.4, 2.9)	1.4 (0.4, 4.6)	1.6 (0.6, 4.5)
Other relative or roommate of parent	*ref*	*ref*	*ref*	*ref*
Sex				
Male	0.9 (0.4, 2.1)	0.7 (0.3, 1.5)	0.8 (0.3, 2.3)	0.7 (0.3, 1.8)
Female	*ref*	*ref*	*ref*	*ref*
Categorical Age				
18-34	1.3 (0.6, 3.1)	1.3 (0.6, 2.7)	1.0 (0.4, 2.7)	0.7 (0.3, 1.7)
≥ 35	*ref*	*ref*	*ref*	*ref*

Abbreviations: [¥]OR: odds ratio; [^]CL: confidence limits.

[1] The dependent variable (DV) was assessed with the question: *'How dangerous do you think it would be for a child (6 years old or younger) if [1 or 2 drops; a teaspoon or more] of e-liquid got in their eye?*' The reference category for the DV is *'Not or minimally dangerous'*.

[2] We adjusted for race/ethnicity and highest education completed in these models. Neither of these variables was significantly associated with the dependent variables in any of the models examined, and therefore are not included in the results table.

Chapter 4:
Manuscript for Study 3: Who's watching the children?: Adults' awareness of nicotine e-liquid handling practices in homes with young children

Formatted according to criteria listed by the journal *Health Education and Behavior*

Who's watching the children?:
Adults' awareness of nicotine e-liquid handling practices in homes with young children
(116 characters & spaces)

Who's watching the children?:
Adults' awareness of nicotine e-liquid handling practices in homes with young children
(118 characters & spaces)

Authors: Catherine B. Kemp, BSN, MHA[a,b], Claire Adams Spears, Ph.D.[a,b], David L. Ashley, Ph.D.[a,c] and Terry F. Pechacek, Ph.D.[a,d],
Author Affiliations:
[a] Tobacco Center of Regulatory Science (TCORS), Georgia State University School of Public Health, Atlanta, GA 30303;
[b] Division of Health Promotion and Behavior, Georgia State University School of Public Health, Atlanta, GA 30303;
[c] Division of Environmental Health, Georgia State University School of Public Health, Atlanta, GA 30303.
[d] Division of Health Management and Policy, Georgia State University School of Public Health, Atlanta, GA 30303.

Corresponding Author:
Catherine B. Kemp, BSN, MHA
Tobacco Center of Regulatory Science (TCORS)
Georgia State University School of Public Health
Urban Life Building Room 848
140 Decatur Street
Atlanta, GA 30303
Short title: Nicotine e-Liquid Handling in Homes with Young Children (55 characters & spaces)
Word counts:
Abstract: 249 (limit is 250)
Body: 1961 (limit is 2000)

Tables/Figures
Tables: 2 (limit is 2)
References: 15 (limit is 15)

Funding Source: This research was supported by grant number P50DA036128 from the NIH/NIDA and FDA Center for Tobacco Products (CTP) and by grant number K23AT008442 from the NIH/NCCIH. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or the FDA.
Financial Disclosure: The authors have no financial relationships relevant to this article to disclose.
Potential Conflict of Interest: The authors have no potential or actual conflicts of interest relevant to this article to disclose.
Clinical Trial Registration: Not applicable.
Abbreviations: EVP- electronic vapor products; NEL- Nicotine e-liquids; US- United States; CL- confidence limits; *p*- probability; *F*- Fisher's exact test; *df* - degrees of freedom; MTurk- Amazon Mechanical Turk

Abstract

Background
United States (US) cases of childhood nicotine e-liquid (NEL) exposures have risen sharply.

Aims
To: document adults' knowledge of NEL handling practices in homes where electronic vapor products (EVPs) are used; examine whether reported handling practices differ based on demographic characteristics and EVP-use status; and examine associations between harm perceptions and handling practices.

Methods
US adults (≥ 18 years, $n = 433$) living in EVP-using homes with a child (≤ 6 years) completed online surveys in April 2018 regarding NEL risk-to-children perceptions and knowledge of NEL handling practices.

Results
While a minority of EVP-users (11.7%, 95%CL:7.6-15.8) and non-users (19.6%, 95%CL:13.6-25.7) perceived NEL exposures being *very dangerous* to children, perceiving NEL exposures as *very dangerous* (versus *minimally or not dangerous at all*) to children was significantly associated with *always* using child-proof caps (aOR:3.7, 95%CL:1.1-12.0) in multinomial models. Also, in multinomial models, non-users (versus EVP-users) had significantly higher odds of responding 'I don't know' regarding NEL-related practices, including: child-proof caps (aOR:3.2, 95%CL:1.3-7.7), replacing bottle cap with pouring tip (aOR:10.9, 95%CL:3.8-30.9), and mixing NEL in their homes (aOR:12.1, 95%CL:3.5-42.2.

Discussion
While perceptions that NEL exposures are *very dangerous* to children were associated with *always* using child-proof caps, only a minority of the sample had such perceptions. EVP non-users have greater odds of responding they *don't know* how NEL are being handled in the home.

Conclusion
Measures to improve adults' knowledge of nicotine's harmfulness to children may increase NEL safe handling practices such as always use using child-proof caps on NEL containers.

Introduction

As adults' use of electronic vapor products (EVP) to consume nicotine has grown significantly in the United States (US) (Bao, Xu, Lu, Snetselaar, & Wallace, 2018), so too have unintended exposures to nicotine e-liquids (NEL) among young children (≤ 6 years) (Govindarajan, Spiller, Casavant, Chounthirath, & Smith, 2018; Kamboj, Spiller, Casavant, Chounthirath, & Smith, 2016). Despite an approximately 19% drop in reported cases of young child exposures following national mandates for NEL child-resistant packaging (Govindarajan et al., 2018), several hundred cases are reported monthly to US poison control centers ("Electronic Cigarettes and Liquid Nicotine Data," 2018).

Research regarding NEL storage practices in homes of EVP users where young child(ren) live is scant. Garbutt et al. (2015) examined this issue among parents of child patients attending an urban US pediatrics practice; they found that 36% of their sample neither had child-proof caps on NEL bottles, nor stored those bottles in a locked space. The most common NEL storage spaces were in a drawer or cupboard, followed by a purse or personal bag. In addition, studies have found that perceptions of NEL-related harm to children vary by exposure mode (Garbutt et al., 2015; Kemp, Spears, Ashley, & Pechacek, 2018), with approximately twice the proportion of each study's sample characterizing NEL ingestion by a child as "very dangerous" as those who characterized skin contact as "very dangerous."

The present study's design was guided by the Protection Motivation Theory (PMT) (Prentice-Dunn & Rogers, 1986). PMT posits that the accuracy of individuals' (i.e., adults in the home) perceptions of the severity of and susceptibility to a threat (i.e., children being exposed to NEL) predicts their motivation to protect against that threat (i.e. NEL safe-handling practices). Previous research (Kemp et al., 2018) indicates that EVP-users are less likely (versus non-users)

to perceive NEL as being very harmful to children. This study's design also considered prior research indicating that while adults in households with children may recognize the potential harms of exposure to commonly used household chemicals (such as bleach), they have low awareness and/or compliance with safe storage recommendations (Kaufman, Smolinske, & Keswick, 2005; Smolinske & Kaufman, 2007). Thus, understanding NEL-related risk perceptions, awareness, and practices of all adults in the home is important in determining what measures are needed to protect children from this exposure.

Considering this conceptual framework and the paucity of evidence describing NEL-related practices in homes with young children, this pilot study sought to: 1) document adults' knowledge of NEL handling practices in EVP-using homes where at least one child (≤6 years) lives; and 2) examine whether NEL handling practices differ based on demographic characteristic and EVP-use status; and 3) examine relationships NEL-related between harm perceptions and handling practices.

Methods

An online survey was conducted on the Amazon Mechanical Turk Platform (MTurk) in April 2018 to a convenience sample of adult (≥ 18 years) US residents who lived in a home with at least one child (≤ 6 years). These adults were either current EVP-users or had never used EVPs but lived with a current user (non-user) was conducted. Details regarding data collection are documented elsewhere (Kemp et al., 2018). The study protocol was reviewed by the Georgia State University (GSU) Institutional Review Board and determined to be exempt.

Measures

Socio-Demographic Characteristics

Demographic attributes, including sex, race/ethnicity ('White non-Hispanic' (NH) and 'Black non-Hispanic, Hispanic, or Other'), age ('18-34 years' and '35 years and older'), relationship to the youngest child ('other relative or cohabiting' and 'parent or parent figure') residing in the home, and education ('some college or less' and 'Bachelor's degree or higher') were assessed.

EVP use

Adults who described another adult living with them or themselves as having used EVP in the preceding 30 days (n = 678) were asked if the e-liquids used in their homes usually contained nicotine. Those who answered 'yes' (n = 581) or 'I don't know' (n = 53) were eligible for this study; those who responded 'no' (n = 44) were excluded, as the study is concerning nicotine-containing e-liquids.

Perceptions of NEL-related Harm

Participants were asked to indicate how dangerous (response options: '*Very dangerous*', '*Moderately dangerous*', '*Minimally or not dangerous at all*') they thought two doses ('*1 or 2 drops*', '*a teaspoonful or more*') of five modes ('*On the lips*', '*In the eyes*', '*In the nose*', '*Skin contact*', and '*Swallowing*') of NEL exposure would be for a child (≤ 6 years). The equally weighted scores for these items were added together, then divided by 10 to form a composite measure of 'NEL-related harm to children' perceptions.

NEL Handling Practices in the Home

In the absence of existing validated measures, we consulted with tobacco control and child safety experts in developing survey questions to assess NEL handling practices.

Participants were asked to indicate how often the following occurred in their homes: '*The e-liquids used in my home have child-proof caps*'; '*The bottle cap is replaced with a pouring tip*', and '*Nicotine e-liquids are mixed in my home*'. Response options included: '*Always*', '*Sometimes*', '*Never*', and '*I don't know*'.

Data Analysis

Using SAS software, version 9.4 (©2012, The SAS Institute, Cary, NC), descriptive statistics and *F* tests were computed to evaluate demographic characteristics, NEL harm perceptions, and responses regarding NEL-related practices in the home in relation to EVP-use status. Adjusted relationships between the IVs (Demographic characteristics, EVP-use status, and NEL-related harm perceptions) and each DV (NEL-related practices) were evaluated with multinomial logistic regression models.

Results

The univariate and bivariate descriptive statistics (Table 1) demonstrate that EVP-users and non-users in this sample were demographically similar in terms of race/ethnicity, age, highest education completed, and relationship with the youngest child in the home. A significantly larger proportion of EVP-users ($p = .004$) characterized children ($\leq$ 6 years) being exposed to NEL as "*minimally or not dangerous at all*'. A minority of EVP-users (11.7%, 95% confidence limits (CL): 1.7-15.8) and non-users (19.6%, 95%CL: 13.6-25.7) characterized NEL exposures as *very dangerous* to children. Among the overall sample (no significant intergroup differences by EVP-use status were observed), less than half (47.4% 95%CL: 42.7, 52.2) reported that the NEL *always* have child-proof caps and a third (33.7%, 95%CL: 29.2, 38.2) reported the NEL were *sometimes* being mixed in their homes. Significantly larger proportions of non-users (versus EVP-users) responded '*I don't know*' to all of the NEL handling practices in the home.

In the multinomial logistic regression models, those who perceived NEL exposures as *very dangerous* (versus *minimally or not dangerous at all*) to children had significantly higher odds of *always* using child-proof caps (aOR: 3.7, 95%CL: 1.1-12.0). Non-users (versus EVP-users) had significantly higher odds of responding '*I don't know*' to: whether NEL in their homes have child-proof caps (aOR: 3.2, 95%CL: 1.3-8.0), if the NEL bottle cap is replaced with a pouring tip (aOR: 13.0, 95%CL: 4.6-36.7); and if NEL are mixed in their homes (aOR: 9.8, 95%CL: 2.7-35.6). In addition, Black NH, Hispanic, or Other race persons (aOR: 3.0, 95%CL: 1.2-7.7) had significantly greater odds (versus White NH persons) of reporting that NEL are *always* mixed in their homes.

Discussion

This foundational study examined adult EVP-users' and non-users' awareness of and/or practices related to NEL in homes where young (≤ 6 years) children live and found important knowledge gaps and opportunities to improve safe handling practices in homes where young children reside. For example, only half of non-users and less than half of EVP-users reported that the NEL containers in their homes *always* had child-proof caps. Approximately 34% and 44% of EVP-users and non-users (respectively) reported that NEL are sometimes or always mixed in their homes. A minority of respondents perceived NEL exposure as being *very dangerous* to children (≤ 6 years). In spite of these identified gaps, respondents characterizing NEL exposure as *very dangerous* to children are significantly more likely to report *always* having child-proof caps on NEL containers in their homes.

These findings support the PMT-informed modelled relationship of perceiving NEL exposures as harmful to children predicting protective behavior (NEL *always* having child-proof caps) (Prentice-Dunn & Rogers, 1986) and suggests that improving adults' knowledge of

nicotine's harmfulness to children could improve NEL safe-handling practices. Protecting children from NEL exposures has been identified as a priority; a principle source of EVP-related morbidity and mortality is NEL exposures among young children, and NEL ingestion can be fatal (National Academies of Sciences, 2018). Nicotine's harmfulness to children from fetal development through adolescence is well documented in the literature (England et al., 2017; Govindarajan et al., 2018; *The health consequences of smoking – 50 years of progress: a report of the Surgeon General*, 2014; Kamboj et al., 2016).

This study also found that some EVP non-users lack awareness of NEL handling practices in their homes. Although concerning, it highlight an opportunity to improve non-users' NEL-related knowledge, engaging them as another line of protection against children from NEL exposures.

Although a US Federal law enacted in 2016 requires child-proof packaging for all NEL (Nelson, 2016), less than half of this sample reported always using child-proof caps on NEL in their homes. Furthermore, the impact of that law has been modest (Govindarajan et al., 2018), highlighting the importance of developing multifaceted approaches to preventing child NEL exposures.

While evidence-based best practices for NEL handling in the home have yet to be developed, the US Food and Drug Administration (FDA) recently published recommendations, such as always storing NEL out of children's reach and teaching children that only adults should handle NEL ("Do You Vape? See These Tips on How to Keep E-Liquids Away from Children," 2018) ("Do You Vape? See These Tips on How to Keep E-Liquids Away from Children," 2018) **to** protect children from NEL exposures. Research examining consumer storage practices of common household hazardous materials in relation to child poisoning risks in the home have

similarly found inconsistencies, such as not always using childproof packing to store hazardous chemicals (Kaufman et al., 2005; Smolinske & Kaufman, 2007). General evidence-based home-safety practices could protect children from NEL exposures, such as teaching parents to identify when a hazard (i.e., NEL) is reachable and accessible to a child and developing mitigation strategies (Guastaferro, Lutzker, Graham, Shanl, & Whitaker, 2012).

NEL-related practices in homes where young children live is an important issue; a 2018 review of EVP-focused evidence concluded that a principle source of EVP-related morbidity and mortality is young children ingesting or absorbing (via eye or dermal contact) NEL, and ingestion can be fatal (National Academies of Sciences, 2018). Nicotine's potential harmfulness to children from fetal development through adolescence is well documented in the literature ("Deeming Tobacco Products To Be Subject to the Federal Food, Drug, and Cosmetic Act," 2016; England et al., 2017; Govindarajan et al., 2018; Kamboj et al., 2016).

This study was limited by having no existing validated measures to evaluate NEL handling practices in homes with children. To mitigate this concern, we consulted with subject matter experts when developing the survey. We also requested feedback from the first 25 respondents; no concerns were raised. The generalizability of these findings are limited by the sampling frame (MTurk). Being an exploratory study, we were not seeking representativeness; we sought to describe adults' EVP-related behaviors in homes where children live to identify factors to be explored in future research.

Summary and Conclusions

NEL exposures are a principle source of EVP-related harm to American children. This study found that a substantial proportion of adult EVP-users and non-users living with small

children lacked adequate knowledge of NEL's harmfulness to children and reported NEL storage practices were inadequate to protect children from NEL exposures. Despite these gaps, this study identified a relationship between perceiving NEL exposure as *very dangerous* to children and higher odds of always using childproof caps on NEL containers. Interventions are needed to improve adults' knowledge of NEL's harmfulness to children and improve safe handling practices in homes.

References

Bao, W., Xu, G., Lu, J., Snetselaar, L. G., & Wallace, R. B. (2018). Changes in electronic cigarette use among adults in the united states, 2014-2016. *JAMA, 319*(19), 2039-2041. doi:10.1001/jama.2018.4658

Deeming Tobacco Products To Be Subject to the Federal Food, Drug, and Cosmetic Act, 21 CFR Parts 1100, 1140, and 1143 C.F.R. (2016).

Do You Vape? See These Tips on How to Keep E-Liquids Away from Children. (2018). *Consumer Updates.* Retrieved from https://www.fda.gov/forconsumers/consumerupdates/ucm606055

Electronic Cigarettes and Liquid Nicotine Data. (2018, 04/30/2018). *American Association of Poison Control Centers.* Retrieved from https://aapcc.s3.amazonaws.com/files/library/E-cig__Nicotine_Web_Data_through_4.2018_4Rfoq1v.pdf

England, L. J., Aagaard, K., Bloch, M., Conway, K., Cosgrove, K., Grana, R., . . . Wakschlag, L. (2017). Review article: Developmental toxicity of nicotine: A transdisciplinary synthesis and implications for emerging tobacco products. *Neuroscience and Biobehavioral Reviews, 72*, 176-189. doi:10.1016/j.neubiorev.2016.11.013

Garbutt, J. M., Miller, W., Dodd, S., Bobenhouse, N., Sterkel, R., & Strunk, R. C. (2015). Tobacco and Substance Abuse: Parental Use of Electronic Cigarettes. *Academic Pediatrics, 15*, 599-604. doi:10.1016/j.acap.2015.06.013

Govindarajan, P., Spiller, H. A., Casavant, M. J., Chounthirath, T., & Smith, G. A. (2018). E-Cigarette and Liquid Nicotine Exposures Among Young Children. *PEDIATRICS, 141*(5). doi:10.1542/peds.2017-3361

The health consequences of smoking – 50 years of progress: a report of the Surgeon General. (2014). Atlanta, GA: National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

Kamboj, A., Spiller, H. A., Casavant, M. J., Chounthirath, T., & Smith, G. A. (2016). Pediatric Exposure to E-Cigarettes, Nicotine, and Tobacco Products in the United States. *PEDIATRICS, 137*(6). doi:10.1542/peds.2016-0041

Kaufman, M. M., Smolinske, S., & Keswick, D. (2005). Assessing poisoning risks related to storage of household hazardous materials: using a focus group to improve a survey questionnaire. *Environmental Health: A Global Access Science Source, 4*, 16-16.

Kemp, C. B., Spears, C. A., Ashley, D. L., & Pechacek, T. F. (2018). *Vapers' Harm Perceptions of Child Exposure to Nicotine E-liquids*.

National Academies of Sciences, E., and Medicine. (2018). *Public health consequences of e-cigarettes*. Retrieved from Washington, D.C.: https://www.nap.edu/download/24952

Child Nicotine Poisoning Prevention Act of 2015, 15 USC 1471 C.F.R. (2016).

Prentice-Dunn, S., & Rogers, R. (1986). Protection Motivation Theory and preventive health: beyond the Health Belief Model. *Health Education Research, 1*(3), 153-161.

Smolinske, S. C., & Kaufman, M. M. (2007). Consumer perception of household hazardous materials. *Clinical Toxicology (15563650), 45*(5), 522-525. doi:10.1080/15563650701354192

Table 1. Univariate and bivariate analyses of sample demographics and risk perceptions of children (≤ 6 years old) being exposed to nicotine e-liquids at different doses and by different modes stratified by EVP use status ($N = 433$).

	Univariate	Bivariate By EVP_USE variable		
	% (95% CL*)	EVP user % (95% CL*)	Never-user, lives w/EVP user % (95% CL*)	$F_{(df)}$, p
EVP use status	$N = 433$	59.1 (54.5, 63.8)	40.9 (36.2, 45.5)	$14.4_{(1,432)}$, .0002
Socio-Demographic Characteristics				
Relationship with youngest child in the home				$0.1_{(1,432)}$, .78
Parent or parent figure	75.3 (71.2, 79.4)	75.8 (70.5, 81.1)	74.6 (68.1, 81.0)	
Other relative or roommate of parent	24.7 (20.6, 28.8)	24.2 (19.0, 29.5)	25.4 (19.0, 31.9)	
Sex				$17.7_{(1,432)}$, <.0001
Male	50.6 (45.8, 55.3)	**59.0 (52.9, 65.0)**	38.4 (31.2, 45.6)	
Female	49.4 (44.7, 54.2)	**41.0 (35.0, 47.1)**	**61.6 (54.4, 68.8)**	
Race/Ethnicity				$0.1_{(1,432)}$, .78
White, NH	78.1 (74.1, 82.0)	78.5 (73.5, 83.6)	77.4 (71.2, 83.6)	
African-American, Hispanic, or Other	21.9 (18.0, 25.9)	21.5 (16.4, 26.5)	22.6 (16.4, 28.8)	
Categorical Age				$0.2_{(1,432)}$, .70
18-34	53.1 (48.4, 57.8)	52.3 (46.2, 58.5)	54.2 (46.9, 61.6)	
≥ 35	46.9 (42.2, 51.6)	47.7 (41.5, 53.8)	45.8 (38.4, 53.1)	
Highest education completed				$2.9_{(1,430)}$, .09
<=Some college	30.9 (26.5, 35.2)	34.0 (28.2, 39.8)	26.3 (19.7, 32.8)	
>= Bachelor's	69.1 (64.8, 73.5)	66.0 (60.2, 71.8)	73.7 (67.2, 80.3)	
Perceptions of EVP-related Harm				
How dangerous for you think it would be for a child (≤ 6 years) to swallow or get a few drops or a teaspoon or more of nicotine e-liquids on their skin, lips, eyes, or nose?				$5.6_{(2,812)}$,.004
Very dangerous	15.0 (11.5, 18.5)	11.7 (7.6, 15.8)	19.6 (13.6, 25.7)	
Moderately dangerous	62.2 (57.4, 66.9)	60.3 (54.0, 66.5)	64.9 (57.6, 72.1)	
Minimally or not dangerous at all	22.9 (18.8, 26.9)	28.0 (22.3, 33.8)	15.5 (10.0, 21.0)	
NEL Handling Practices in the Home				
The e-liquids used in electronic vaporizer products in my home have child-proof caps.				$12.2_{(3,1275)}$, .007
Always	47.4 (42.7, 52.2)	50.4 (44.2, 56.6)	43.2 (35.8, 50.5)	
Sometimes	28.4 (24.1, 32.7)	29.2 (23.5, 34.9)	27.3 (20.7, 33.9)	
Never	12.9 (9.7, 16.1)	13.6 (9.3, 17.9)	11.9 (7.1, 16.7)	
I don't know	11.3 (8.3, 14.3)	6.8 (3.7, 9.9)	**17.6 (12.0, 23.3)**	
The bottle cap is replaced with a pouring tip.				$12.2_{(3,1269)}$, <.0001
Always	13.0 (9.8, 16.2)	12.4 (8.3, 16.6)	13.7 (8.6, 18.8)	
Sometimes	27.1 (22.9, 31.4)	31.7 (15.9, 37.5)	20.6 (14.6, 26.6)	
Never	50.0 (45.2,54.8)	53.0 (46.8, 59.2)	45.7 (38.3, 53.1)	
I don't know	9.9 (7.1, 12.8)	2.8 (0.7, 4.9)	**20.0 (14.1, 26.0)**	
Nicotine e-liquids are mixed in my home.				6.7 $_{(3,1270)}$, .0002
Always	5.9 (3.6, 8.1)	6.0 (3.1, 9.0)	5.7 (2.3, 9.2)	
Sometimes	33.7 (29.2, 38.2)	37.8 (31.7, 43.8)	28.0 (21.3, 34.7)	
Never	53.5 (48.8, 58.3)	53.8 (47.6, 60.0)	53.1 (45.7, 60.6)	
I don't know	6.8 (4.4, 9.3)	2.4 (0.5, 4.3)	**13.1 (8.1, 18.2)**	

Abbreviations: EVP- Electronic Vapor Product; aOR- adjusted odds ratio; CL- confidence limits. **Bolded OR** indicates statistical significance at $p < .05$

Table 2. Results of logistic regression models regressing demographic characteristics, current EVP use status, and risk perceptions related to a child (≤ 6 years) being exposed to second-hand EVP vapor regressed on reported nicotine e-liquid and EVP-product handling and storage practices in EVP-using homes.

		Model 1	Model 2	Model 3
		The e-liquids used in EVPs in my home have child proof caps. [b,c] **aOR (95% CL)**	**The bottle cap is replaced with a pouring tip.** [b,c] **aOR (95% CL)**	**Nicotine e-liquids are mixed in my home** [b,c] **aOR (95% CL)**
EVP use status[d]				
Non EVP-user, lives with user				
	Always	0.8 (0.4, 1.6)	1.5 (0.8, 2.8)	1.2 (0.5, 2.9)
	Sometimes	1.1 (0.5, 2.2)	0.8 (0.5, 1.4)	0.7 (0.5, 1.2)
	I don't know	**3.2 (1.3, 8.0)**	**13.0 (4.6, 36.7)**	**9.8 (2.7, 35.6)**
Categorical age[e]				
18-34 years				
	Always	0.9 (0.4, 1.7)	0.9 (0.5, 1.6)	0.9 (0.3, 2.2)
	Sometimes	0.9 (0.4, 1.9)	1.1 (0.7, 1.9)	**0.6 (0.4, 1.0)**
	I don't know	0.7 (0.3, 1.8)	1.8 (0.8, 3.9)	0.9 (0.3, 2.3)
Race/ethnicity[f]				
African-American non-Hispanic, Hispanic, multi-racial, or other				
	Always	0.5 (0.2, 1.1)	1.6 (0.8, 3.3)	**3.0 (1.2, 7.7)**
	Sometimes	0.7 (0.3, 1.5)	1.7 (0.9, 3.0)	1.1 (0.6, 1.9)
	I don't know	0.9 (0.3, 2.4)	1.1 (0.4, 2.9)	0.9 (0.3, 2.9)
Highest education[g]				
Some college or less				
	Always	1.5 (0.7, 3.1)	1.3 (0.6, 2.6)	0.4 (0.1, 1.4)
	Sometimes	1.2 (0.5, 2.6)	1.1 (0.6, 2.0)	0.9 (0.5, 1.4)
	I don't know	2.1 (0.8, 5.4)	1.9 (0.8, 4.4)	1.9 (0.8, 4.8)
Relationship to youngest child in the home[h]				
Other relative or cohabiting				
	Always	1.4 (0.7, 2.9)	0.8 (0.4, 1.6)	0.6 (0.2, 1.5)
	Sometimes	2.2 (1.0, 4.8)	0.8 (0.5, 1.4)	1.1 (0.6, 1.9)
	I don't know	1.2 (0.5, 2.9)	0.7 (0.3, 1.6)	1.0 (0.4, 2.6)
How dangerous for you think it would be for a child (≤ 6 years) to swallow or get a few drops or a teaspoon or more of nicotine e-liquids on their skin, lips, eyes, or nose?[i]				
Very Dangerous				
	Always	**3.7 (1.1, 12.0)**	0.8 (0.3, 2.2)	0.3 (0.1, 1.6)
	Sometimes	0.9 (0.3, 3.5)	0.5 (0.2, 1.2)	0.6 (0.3, 1.3)
	I don't know	0.6 (0.1, 3.5)	2.1 (0.7, 6.2)	4.9 (0.5, 47.5)
Moderately dangerous				
	Always	1.7 (0.8, 3.8)	0.7 (0.3, 1.6)	0.5 (0.2, 1.5)
	Sometimes	1.0 (0.5, 2.2)	0.8 (0.4, 1.4)	0.7 (0.4, 1.1)
	I don't know	1.4 (0.5, 3.9)	0.5 (0.2, 1.3)	3.7 (0.4, 32.9)

Abbreviations: EVP- Electronic Vapor Product; aOR- adjusted odds ratio; CL- confidence limits. Unweighted statistics are, Bolded **OR** indicates statistical significance at $p < .05$

[b]Subjects were asked to indicate how often this occurred in their home; response options included: '*Always*'; '*Sometimes*'; '*Never*'; and '*I don't know*'

[c]The reference category for the dependent variables is '*Never*'.

[d]EVP user refers to an adult (≥ 18 years) who has used a nicotine-containing EVP is past 30 days, EVP-user is the reference category.

[e]'*35 years and older'* is the reference category

[f]'*White, (NH)*' is the reference category

[g]'*Bachelor's degree or higher*' is the reference category

[h]'*Parent or parent figure*' is the reference category

[i]'*Minimally or not dangerous at all*' is the reference category

Chapter 5:
Summary and Conclusions

Summary

The research carried out in this dissertation is among the first to examine adults' risk perceptions of NEL exposures causing harm to children. Study 1 (Chapter 2) identified statistically significant and practically relevant associations between current use of tobacco products and lower likelihood of perceiving nicotine as being definitely harmful when used children less than 13 years old in a large U.S. nationally representative sample. In addition, females were significantly more likely (versus males) and Black non-Hispanic (NH) individuals, Hispanic individuals, and other NH individuals were significantly less likely (versus White, NH individuals) to perceive nicotine as being definitely harmful when used by children in Study 1.

Study 2 (Chapter 3) built on this evidence by examining adults' risk perceptions of the danger to children (6 years and younger) being exposed to two doses of nicotine NEL ('1 or 2 drops' and 'a teaspoon or more') by five different modes (on the skin, in the eye, on the lips, in the nose, and by swallowing), for a total of ten dose/exposure mode dyads. To my knowledge, this is the first such study to examine specific doses in combination with specific exposure modes. Consistent with Study 1 finding that current tobacco product users were less likely to characterize nicotine use in children (<13 years), Study 2 found that current ENDS users who live in a home with at least one child (≤ 6 years) were significantly less likely (versus adult ENDS never-users living in never-user homes with at least one child) to perceive nicotine as being moderately or very dangerous to children in 70% of the dose/mode dyads examined. Also similar to Study 1, males in Study 2 were significantly less likely to perceive nicotine exposure as being 'very dangerous' in some of the dose/mode dyads examined.

Study 3 (Chapter 4) built on the evidence produced in Study 2 by examining the relationship between adults' risk perceptions (quantified as a composite measure of the

dose/mode risk perceptions examined in Study 2) and behaviors related to NEL handling practices in homes where at least one adult current ENDS-user and at least one child (≤ 6 years) lived. The NEL practices included using child-proof caps of NEL, replacing the NEL cap with a pouring tip, and NEL being mixed in the home. Study 3 found that roughly half of both ENDS-users and non-users reported that the most desired practices from a child-safety point-of-view (i.e., NEL containers always having child-proof caps, bottle caps never replaced with pouring tips, and NEL never mixed in homes) were followed. These results indicate opportunities to improve safe NEL handling practices in homes with children through proximal and distal-level interventions. They also highlight the need for more research in this area to understand more clearly how NEL and ENDS materials are being used and stored in homes with young children.

Study 3 hypothesized that perceptions of nicotine being 'very dangerous' would be associated with reporting of more protective NEL practices. This hypothesis was supported, in that subjects who perceived NEL exposure as being 'very dangerous' were significantly more likely to report that NEL containers in their homes 'always' had child-proof caps. When combined with the finding that only a minority of respondents (regardless of ENDS-use status) perceived NEL exposure as being *very dangerous* to children (≤ 6 years), these results suggest that improving adults' knowledge of the dangers of nicotine exposure to children might increase the likelihood of their always using childproof caps on NEL containers.

Another important finding in Study 3 is that ENDS non-users were significantly more likely to respond that they didn't know how NELs were handled in their homes across the three categories of practices examined. These findings highlight an important opportunity to engage non-ENDS-using adults in ENDS-using homes as a second-line of defense to protect children from NEL exposures; these adults might benefit from educational interventions to alert them to

the harms acute and chronic exposures to nicotine causes to children. While ENDS users may have the most proximity to and control over NEL handling in the home, they also appear to estimate lower potential risks of child NEL exposures, compared to EVP non-users. Non-users in ENDS-using homes can provide important reinforcement of safe-handling behaviors by advocating for, establishing, and enforcing safe handling practices in their homes. Future research should focus on developing effective messaging and communication channels to reach these adults; such research can be modeled on previous studies related to smoke-free home rules to protect children in the home.[107,108]

The research outlined in this dissertation makes important contributions to the science of Public Health (PH) by developing our understanding of which population subgroups are more likely to lack adequate knowledge not only of nicotine's harmfulness to children, but also whether/how NEL and other nicotine products are be handled in their homes. Such knowledge is essential in developing effective PH harm reduction interventions. For example, this research identified statistical relationships between current tobacco product use and lower odds of perceiving nicotine as harmful to children in general. Then it more specifically, and perhaps more importantly, identified relationships linking current ENDS-use status to risk perceptions of NEL exposures being harmful to children. The knowledge that tobacco product users generally and ENDS-users specifically are less likely to appreciate how harmful nicotine exposure is to children indicates a need to educate these product users about nicotine-specific harms to children and their responsibility to prevent children from being exposed to nicotine-containing products.

Another important example of how this research contributes to PH science is the finding that ENDS non-users living with ENDS-users are significantly more likely to indicate that they lack knowledge of NEL handling practices in their homes. Non-users can play an important role

in protecting children from NEL exposure in their homes. PH messaging educating them of NEL's harmfulness to children in their homes, what the different products look like, and suggested handling rules (i.e., 'Always ensure NEL in your home has childproof packaging'; 'Never allow a child to handle NEL or ENDS devices'; 'If a child is exposed to NEL, seek immediate medical attention'; etc.) to be enforced in their homes. Furthermore, messaging regarding NEL handling in the home could also be framed in the context of being handled the way other child hazards (such as prescription drugs, cleaning chemicals, solvents, etc.) are managed, to reinforce the seriousness of child nicotine toxicity.

Conclusions

Future research is needed to replicate the findings of Study 2 and Study 3 in larger, more representative samples of adults to confirm and further explicate these findings. Children have been identified as a priority population by the Surgeon General[55] in an effort to reduce tobacco product-related harms. ENDS-use research has focused almost exclusively on factors associated with intended use. Despite the growing incidence of adverse clinical events resulting from children's exposures to NEL and the evidence indicating that ENDS use is growing fastest among young adults (in their child-bearing years), there is a paucity of research examining adults' risk perceptions or factors associated with children's exposure. In documenting adults' knowledge gaps related to and risk perceptions of child NEL exposures, the research described in this dissertation makes important and novel contributions to Tobacco Regulatory Science. Future research is needed to confirm these findings and further explore child safety issues related to nicotine and NEL exposures.

References

1. Wang TW, Kenemer B, Tynan MA, Tushar S, King B. Consumption of combustible and smokeless tobacco - United States, 2000-2015. *Morbidity and Mortality Weekly Report.* 2016;65(48):1357-1363.
2. King BA, Alam S, Promoff G, Arrazola R, Dube SR. Awareness and Ever-Use of Electronic Cigarettes Among U.S. Adults, 2010–2011. *Nicotine & Tobacco Research.* 2013;15(9):1623-1627.
3. King BA, Patel R, Nguyen KH, Dube SR. Trends in awareness and use of electronic cigarettes among U.S. adults, 2010–2013. *Nicotine & Tobacco Research.* 2015;17(2):219-227.
4. Pericot-Valverde I, Gaalema DE, Priest JS, Higgins ST. E-cigarette awareness, perceived harmfulness, and ever use among U.S. adults. (1096-0260 (Electronic)).
5. Singh T, Arrazol RA, Corey CG, et al. Tobacco Use Among Middle and High School Students — United States, 2011-2015. *MMWR: Morbidity & Mortality Weekly Report.* 2016;65(14):361-367 367p.
6. Wang B, King BA, Corey CG, Arrazola RA, Johnson SE. The awareness and use of non-conventional tobacco products among U.S. students, 2012. *American Journal of Preventative Medicine.* 2014;47(2S1):S36-52.
7. Arrazola RA, Singh T, Corey CG, et al. Tobacco use among middle and high school students - United States, 2011-2014. *MMWR: Morbidity & Mortality Weekly Report.* 2015;64(14):381-385.
8. Corey CG, Ambrose BK, Apelberg BJ, King BA. Flavored Tobacco Product Use Among Middle and High School Students--United States, 2014. *MMWR: Morbidity & Mortality Weekly Report.* 2015;64(38):1066-1070.
9. Carroll-Chapman SL, Wu L-T. E-cigarette prevalence and correlates of use among adolescents versus adults: A review and comparison. *J Psychiatr Res.* 2014;54:43-54.
10. Cooper M, Harrell MB, Perry CL. A Qualitative Approach to Understanding Real-World Electronic Cigarette Use: Implications for Measurement and Regulation. *Preventing Chronic Disease.* 2016;13:E07.
11. Merianos AL, Mancuso TF, Gordon JS, Wood KJ, Cimperman KA, Mahabee-Gittens EM. Dual- and Polytobacco/Nicotine Product Use Trends in a National Sample of High School Students. *American Journal of Health Promotion.* 2018;32(5):1280-1290.
12. Coleman B, Rostron B, Johnson SE, et al. Transitions in electronic cigarette use among adults in the Population Assessment of Tobacco and Health (PATH) Study, Waves 1 and 2 (2013-2015). LID - tobaccocontrol-2017-054174 [pii] LID - 10.1136/tobaccocontrol-2017-054174 [doi]. (1468-3318 (Electronic)).
13. Zhu SH, Zhuang YL, Wong S, Cummins SE, Tedeschi GJ. E-cigarette use and associated changes in population smoking cessation: evidence from US current population surveys. *BMJ.* 2017;358(1756-1833 (Electronic)).
14. McMillen RC, Gottlieb MA, Shaefer RMW, Winickoff JP, Klein JD. Trends in Electronic Cigarette Use Among U.S. Adults: Use is Increasing in Both Smokers and Nonsmokers. *Nicotine & Tobacco Research: Official Journal Of The Society For Research On Nicotine And Tobacco.* 2014.

15. Hu SS, Neff L, Agaku IT, et al. Tobacco Product Use Among Adults - United States, 2013-2014. *MMWR: Morbidity & Mortality Weekly Report.* 2016;65(27):685-691.
16. Schoenborn CA, Gindi RM. QuickStats: Cigarette Smoking Status Among Current Adult E-cigarette Users, by Age Group — National Health Interview Survey, United States, 2015. *MMWR Morb Mortal Wkly Rep.* 2016;16(65):1177.
17. Manigrasso M, Buonanno G, Fuoco FC, Stabile L, Avino P. Aerosol deposition doses in the human respiratory tree of electronic cigarette smokers. *Environ Pollut.* 2015;196(Jan):257-267.
18. Drummond MB, Upson D. Electronic cigarettes. Potential harms and benefits. *Annals of the American Thoracic Society.* 2014;11(2):236-242.
19. Prohibiting sale of e-cigarettes. *American Nurse.* 2015;47(1):4-4.
20. Brown CJ, Cheng JM. Electronic cigarettes: product characterisation and design considerations. *Tobacco Control.* 2014;23 Suppl 2:ii4-ii10.
21. Jimenez Ruiz CA, Solano Reina S, de Granda Orive JI, et al. Special article: The Electronic Cigarette. Official Statement of the Spanish Society of Pneumology and Thoracic Surgery (SEPAR) on the Efficacy, Safety and Regulation of Electronic Cigarettes. *El cigarrillo electrónico Declaración oficial de la Sociedad Española de Neumología y Cirugía Torácica (SEPAR) sobre la eficacia, seguridad y regulación de los cigarrillos electrónicos (Spanish; Castilian).* 2014;50:362-367.
22. Stimson GV, Thom B, Costall P. Disruptive innovations: The rise of the electronic cigarette. *International Journal of Drug Policy.* 2014;25:653-655.
23. Grana R, Benowitz N, Glantz SA. E-Cigarettes: A Scientific Review. *Circulation.* 2014;129(19):1972-1986.
24. Rose SW, Barker DC, D'Angelo H, et al. The availability of electronic cigarettes in US retail outlets, 2012: results of two national studies. *Tobacco Control.* 2014;23(S3):iii10-iii16.
25. Farsalinos KE, Polosa R. Safety evaluation and risk assessment of electronic cigarettes as tobacco cigarette substitutes: a systematic review. *Therapeutic Advances In Drug Safety.* 2014;5(2):67-86.
26. *Regulating Electronic Cigarettes and Similar Devices.* Tobacco Control Legal Consortium; October 2015 2014.
27. Zhu S-H, Sun JY, Bonnevie E, et al. Four hundred and sixty brands of e-cigarettes and counting: Implications for product regulation. *Tobacco Control: An International Journal.* 2014;23(Supp 3):3-9.
28. Czoli CD, Fong GT, Mays D, Hammond D. How do consumers perceive differences in risk across nicotine products? A review of relative risk perceptions across smokeless tobacco, e-cigarettes, nicotine replacement therapy and combustible cigarettes. *Tobacco Control.* 2016.
29. Howard C. Pharm/Tox Corner: A New Source for Nicotine Exposures in Pediatric Patients: Electronic Cigarettes. *Journal of Emergency Nursing.* 2016;42:451-453.
30. Durmowicz EL. The impact of electronic cigarettes on the paediatric population. *Tob Control.* 2014;23(Suppl 2):ii41-46.
31. Brown-Johnson CG, Burbank A, Daza EJ, et al. Research Article: Online Patient–Provider E-cigarette Consultations. Perceptions of Safety and Harm. *American Journal of Preventive Medicine.* 2016.

32. Farsalinos KE, Polosa R. Safety evaluation and risk assessment of electronic cigarettes as tobacco cigarette substitutes: a systematic review. *Ther Adv Drug Saf.* 2014;5(2):67-86.
33. Glasser AM, Collins L, Pearson JL, et al. REVIEW ARTICLE: Overview of Electronic Nicotine Delivery Systems: A Systematic Review. *American Journal of Preventive Medicine.* 2017;52:e33-e66.
34. National Academies of Sciences E, and Medicine. *Public health consequences of e-cigarettes.* Washington, D.C.: National Academy of Science, Committee on the Review of the Health Effects of Electronic Nicotine Delivery Systems;2018.
35. Nayak P, Kemp CB, Redmon P. A Qualitative Study of Vape Shop Operators' Perceptions of Risks and Benefits of E-Cigarette Use and Attitude Toward Their Potential Regulation by the US Food and Drug Administration, Florida, Georgia, South Carolina, or North Carolina, 2015. *Preventing Chronic Disease.* 2016;13:E68.
36. Nicotine without smoke: Tobacco harm reduction. In. London, UK: Royal College of Physicians; 2016:206.
37. Ramamurthi D, Fadadu RP, Jackler RK. Electronic cigarette marketers manipulate antitobacco advertisements to promote vaping. *Tob Control.* 2015.
38. Galloway M. e-cigarettes: a Practice Nurse guide. *Practice Nurse.* 2014;44(10):16-18.
39. Brown J, Beard E, Kotz D, Michie S, West R. Real-world effectiveness of e-cigarettes when used to aid smoking cessation: a cross-sectional population study. *Addiction.* 2014;109(9):1531-1540.
40. Hajek P, Etter J-F, Benowitz N, Eissenberg T, McRobbie H. Electronic cigarettes: review of use, content, safety, effects on smokers and potential for harm and benefit. *Addiction.* 2014;109(11):1801-1810.
41. Palazzolo DL. Electronic Cigarettes and Vaping: A New Challenge in Clinical Medicine and Public Health. A Literature Review. *Frontiers in Public Health.* 2013;1:56.
42. Wagener TL, Siegel M, Borrelli B. Electronic cigarettes: achieving a balanced perspective. *Addiction.* 2012;107(9):1545-1548.
43. Malas M, van der Tempel J, Schwartz R, et al. Electronic cigarettes for smoking cessation: A systematic review. *Nicotine & Tobacco Research.* 2016;18(10):1926-1936.
44. Hartmann-Boyce J, McRobbie H, Bullen C, Begh R, Stead LF, Hajek P. Electronic cigarettes for smoking cessation. *Cochrane Database of Systematic Reviews.* 2016(9).
45. McRobbie H, Bullen C, Hartmann-Boyce J, Hajek P. Electronic cigarettes for smoking cessation and reduction. *The Cochrane Database Of Systematic Reviews.* 2014(12):CD010216.
46. Kalkhoran S, Glantz SA. Articles: E-cigarettes and smoking cessation in real-world and clinical settings: a systematic review and meta-analysis. *The Lancet Respiratory Medicine.* 2016;4:116-128.
47. Franck C, Filion KB, Kimmelman J, Grad R, Eisenberg MJ. Ethical considerations of e-cigarette use for tobacco harm reduction. *Respiratory Research.* 2016;17:1-9.
48. Gostin LO, Glasner AY. E-Cigarettes, Vaping, and Youth. *JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION.* 2014;312(6):595-596.
49. Chatham-Stephens K, Law R, Taylor E, et al. Calls to Poison Centers for Exposures to Electronic Cigarettes -- United States, September 2010-February 2014. *MMWR Morb Mortal Wkly Rep.* 2014;63(13):292-293.

50. Kamboj A, Spiller HA, Casavant MJ, Chounthirath T, Smith GA. Pediatric Exposure to E-Cigarettes, Nicotine, and Tobacco Products in the United States. *Pediatrics.* 2016;137(6).
51. Vakkalanka JP, Hardison LS, Holstege CP. Epidemiological trends in electronic cigarette exposures reported to U.S. Poison Centers. *Clinical Toxicology (15563650).* 2014;52(5):542-548.
52. Jo CL, Ambs A, Dresler CM, Backinger CL. Review Article: Child-resistant and tamper-resistant packaging: A systematic review to inform tobacco packaging regulation. *Preventive Medicine.* 2017;95:89-95.
53. Cheng TR. Chemical evaluation of electronic cigarettes. *TOBACCO CONTROL.* 2014;23:11-17.
54. Buettner-Schmidt K, Miller DR, Balasubramanian N. Electronic Cigarette Refill Liquids: Child-Resistant Packaging, Nicotine Content, and Sales to Minors. *Journal of Pediatric Nursing.* 2016;31:373-379.
55. *The health consequences of smoking--50 years of progress : a report of the Surgeon General.* 2014.
56. Higa de Landoni J. Nicotine. In. *Chemical Safety Information from Intergovernmental Organizations*. Hamilton, Ontario, Canada: IPCS: International Programme on Chemical Safety; 1991.
57. About Nicotine Strength. *How to Choose the Right E-liquid Srength for Your Device.* 2018. https://www.nicvape.com/About-Nicotine-Strengths. Accessed 02/21/2018.
58. Cohen A. Which vaping nicotine level is best for you? *Vaping Guides.* 2017. https://vaping.com/blog/guides/vaping-nicotine-level-best/. Accessed 02/21/2018.
59. Mayer B. How much nicotine kills a human? Tracing back the generally accepted lethal dose to dubious self-experiments in the nineteenth century. *Archives of Toxicology.* 2014;88(1):5-7.
60. Bassett RA, Osterhoudt K, Brabazon T. Nicotine Poisoning in an Infant. *New England Journal of Medicine.* 2014;370(23):2249-2250.
61. Noble MJ, Longstreet B, Hendrickson RG, Gerona R. Unintentional Pediatric Ingestion of Electronic Cigarette Nicotine Refill Liquid Necessitating Intubation. *Annals of Emergency Medicine.*69(1):94-97.
62. Callahan-Lyon P. Electronic cigarettes: human health effects. *Tobacco Control.* 2014;23(S2):ii36.
63. Cantrell F. Adverse Effects of e-Cigarette Exposures. *Journal of Community Health.* 2014;39(3):614-616.
64. Gupta S, Gandhi A, Manikonda R. Accidental nicotine liquid ingestion: emerging paediatric problem. *Archives of Disease in Childhood.* 2014;99(12):1149.
65. Hua M, Talbot P. Review Article: Potential health effects of electronic cigarettes: A systematic review of case reports. *Preventive Medicine Reports.* 2016;4:169-178.
66. Ordonez JE, Kleinschmidt KC, Forrester MB. Electronic Cigarette Exposures Reported to Texas Poison Centers. *Nicotine & Tobacco Research.* 2015;17(2):209-211.
67. Axelsdottir TO, Sigurdsson EL, Gudmundsdottir AM, Kristjansdottir H, Sigurdsson JA. Drug use during early pregnancy: Cross-sectional analysis from the Childbirth

and Health Study in Primary Care in Iceland. *Scandinavian Journal of Primary Health Care.* 2014;32(3):139.
68. Behl M, Rao D, Aagaard K, et al. Evaluation of the Association between Maternal Smoking, Childhood Obesity, and Metabolic Disorders: A National Toxicology Program Workshop Review. *Environmental Health Perspectives.* 2013;121(2):170.
69. Blalock JA, Minnix JA, Mathew AR, Wetter DW, McCullough JP, Jr., Cinciripini PM. Relationship of childhood trauma to depression and smoking outcomes in pregnant smokers. *Journal of Consulting and Clinical Psychology.* 2013;81(5):821-830.
70. Cnattingius S. The epidemiology of smoking during pregnancy: Smoking prevalence, maternal characteristics, and pregnancy outcomes. *Nicotine & Tobacco Research.* 2004;6:S125-S140.
71. England LJ, Bunnell RE, Pechacek TF, Tong VT, McAfee TA. Nicotine and the Developing Human. A Neglected Element in the Electronic Cigarette Debate. *American Journal of Preventive Medicine.* 2015.
72. Ernst M, Moolchan ET, Robinson ML. Articles: Behavioral and Neural Consequences of Prenatal Exposure to Nicotine. *Journal of the American Academy of Child & Adolescent Psychiatry.* 2001;40:630-641.
73. Law KL, Stroud LR, LaGasse LL, Niaura R, Liu J, Lester BM. Smoking during pregnancy and newborn neurobehavior. *Pediatrics.* 2003;111(6):1318-1323 1316p.
74. O'Callaghan FV, Al Mamun A, O'Callaghan M, et al. Maternal smoking during pregnancy predicts nicotine disorder (dependence or withdrawal) in young adults - a birth cohort study. *Australian And New Zealand Journal Of Public Health.* 2009;33(4):371-377.
75. Paz R, Barsness B, Martenson T, Tanner D, Allan AM. Behavioral teratogenicity induced by nonforced maternal nicotine consumption. *Neuropsychopharmacology: Official Publication Of The American College Of Neuropsychopharmacology.* 2007;32(3):693-699.
76. Piper BJ, Corbett SM. Executive Function Profile in the Offspring of Women That Smoked During Pregnancy. *NICOTINE & TOBACCO RESEARCH.* 2012;14(2):191-199.
77. Santos NF, Costa RA. Original Article: Parental tobacco consumption and child development. *Consumo de tabaco parental e desenvolvimento infantil (Portuguese).* 2015;91:366-372.
78. Thakur GA, Sengupta SM, Grizenko N, Schmitz N, Pagé V, Joober R. Maternal smoking during pregnancy and ADHD: a comprehensive clinical and neurocognitive characterization. *Nicotine & Tobacco Research: Official Journal Of The Society For Research On Nicotine And Tobacco.* 2013;15(1):149-157.
79. Tiesler C, Heinrich J. Prenatal nicotine exposure and child behavioural problems. *European Child & Adolescent Psychiatry.* 2014;23(10):913.
80. Caldas JPS, Braghini CA, Mazzola TN, Vilela MMS, Marba STM. Parental tobacco consumption and child development. *Consumo de tabaco parental e desenvolvimento infantil.* 2015;91(4):366.
81. Black A, Beard E, Brown J, Fidler J, West R. Beliefs about the harms of long-term use of nicotine replacement therapy: perceptions of smokers in England. *Addiction.* 2012;107(11):2037-2042.
82. England LJ, Tong VT, Koblitz A, Kish-Doto J, Lynch MM, Southwell BG. Perceptions of emerging tobacco products and nicotine replacement therapy among pregnant

women and women planning a pregnancy. *Preventive Medicine Reports.* 2016;4:481-485.
83. Brewer NT, Morgan JC, Baig SA, et al. Public understanding of cigarette smoke constituents: three US surveys. *Tob Control.* 2016;Published Online First: 06 December 2016(1468-3318 (Electronic)).
84. Poison prevention packaging standards, Title 16, vol. 2(1970).
85. Testing procedure for special packaging, Title 16, vol. 2(1970).
86. Backinger CLM, Helen I.; Ashley, David L. The FDA "Deeming Rule" and Tobacco Regulatory Research. *Tobacco Regulatory Science.* 2016;2(3):290-293.
87. *Extension of Certain Tobacco Product Compliance Deadlines Related to the Final Deeming Rule: Guidance for Industry.* Silver Spring, MD: FDA Center for Tobacco Products; November 2017 2017.
88. Govindarajan P, Spiller HA, Casavant MJ, Chounthirath T, Smith GA. E-Cigarette and Liquid Nicotine Exposures Among Young Children. *Pediatrics.* 2018;141(5).
89. Electronic Cigarettes and Liquid Nicotine Data. *American Association of Poison Control Centers* 2018; https://aapcc.s3.amazonaws.com/files/library/E-cig_Nicotine_Web_Data_through_4.2018_4Rfoq1v.pdf. Accessed May 11, 2018.
90. Deeming Tobacco Products To Be Subject to the Federal Food, Drug, and Cosmetic Act, as Amended by the Family Smoking Prevention and Tobacco Control Act; Restrictions on the Sale and Distribution of Tobacco Products and Required Warning Statements for Tobacco Products; Final Rule. In. Washington, D.C.: Department of Health and Human Services, Food and Drug Administration; 2016:134.
91. Ambrose BK, Day HR, Rostron B, et al. Flavored tobacco product use among us youth aged 12-17 years, 2013-2014. *JAMA.* 2015:1-3.
92. Vasiljevic M, Petrescu DC, Marteau TM. Impact of advertisements promoting candy-like flavoured e-cigarettes on appeal of tobacco smoking among children: an experimental study. *Tobacco Control.* 2016.
93. Pepper JK, Ribisl KM, Brewer NT. Adolescents' interest in trying flavoured e-cigarettes. *Tobacco Control.* 2016.
94. Garbutt JM, Miller W, Dodd S, Bobenhouse N, Sterkel R, Strunk RC. Parental Use of Electronic Cigarettes. *Academic Pediatrics.* 2015;15(6):599-604.
95. Gill N, Sangha G, Poonai N, Lim R. E-Cigarette Liquid Nicotine Ingestion in a Child: Case Report and Discussion. *CJEM: Canadian Journal of Emergency Medicine.* 2015;17(6):699.
96. Barnett K. Best Practices for Community Health Needs Assessment and Implementation Strategy Development: A Review of Scientific Methods, Current Practices, and Future Potential. In. Atlanta, GA: Centers for Disease Control and Prevention; 2012.
97. Assessing Community Needs and Resources. In: Holt C, Schneider PM, eds. *Community Tool Box*. Lawrence, KS: University of Kansas; 2017.
98. Rogers RW. A protection motivation theory of fear appeals and attitude change. *Journal of Psychology & Christianity.* 1975;91(1):93-114.
99. Rogers RW. Cognitive an physiological processes in fear appeals and attitude change: a revised theory of protection motivation. In: Cacioppo JT, Petty RE, eds.

Social Psychophysiology: A Source Book. New York: Guilford Publishing; 1983:153-176.
100. Floyd DL, Prentice-Dunn S, Rogers RW. A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology.* 2000;30(2):407-429.
101. Norman P, Boer H, Seydel ER. *Chapter 3: Protection Motivation Theory.* 2nd ed. New York, NY: Maidenhead; 2005.
102. Maddux JE, Rogers RW. Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change. *Journal of Experimental Social Psychology.* 1983;19(5):469-479.
103. Prentice-Dunn S, Rogers R. Protection Motivation Theory and preventive health: beyond the Health Belief Model. *Health Education Research.* 1986;1(3):153-161.
104. Farbod Ebadi F, Mahnaz S, Kamyar M, Shiva Mansouri H, Syyedeh Shahrbanou H. Assessment the Effect of Educational Intervention on Preventive Behaviors of Home Accidents in Mothers with Children Less than 5- Year Based on Protection Motivation Theory (PMT). *International Journal of Pediatrics, Vol 4, Iss 7, Pp 2051-2059 (2016).* 2016(7):2051.
105. Ashida S, Heaney CA, Kmet JM, Wilkins JR, III. Using protection motivation theory and formative research to guide an injury prevention intervention: increasing adherence to the North American guidelines for children's agricultural tasks. *Health Promotion Practice.* 2011;12(3):396-405.
106. Kemp CB, Spears CA, Pechacek TF, Eriksen MP. Adults' Perceptions of Nicotine Harm to Children. *Pediatrics.* 2018.
107. Zhang X, Martinez-Donate AP, Kuo D, Piper M. Beyond cigarette smoking: smoke-free home rules and use of alternative tobacco products. *Perspectives In Public Health.* 2016;136(1):30-33.
108. Ossip DJ, Chang Y, Nabi-Burza E, et al. Research On Smoking: Strict Smoke-free Home Policies Among Smoking Parents in Pediatric Settings. *Academic Pediatrics.* 2013;13:517-523.

Appendices

Appendix 1, Study 1 questions for variables extracted from TCORS Annual Survey data

Variable Name	Survey Question	Response Options
NTHMCHLD	**[Children (under 13 years old)] Most tobacco products, including most electronic vapor products, contain nicotine. When used by the following groups, how harmful is nicotine in amounts usually found in tobacco products?**	0 = 'Not harmful' 1 = 'Unlikely harmful' 2 = 'Maybe harmful' 3 = 'Definitely harmful' 9 = 'Don't know'
PPAGECT4	**Categorical Age**	1 = '18-29' 2 = '30-44' 3 = '45-59' 4 = '60+'
PPEDUCAT	**Categorical education**	1 = 'Less than high school' 2 = 'High school' 3 = 'Some college' 4 = 'Bachelor's degree or higher'
PPGENDER	**Gender**	1 = 'Male' 2 = 'Female'
RACE	**Race/Ethnicity**	1 = 'White, Non-Hispanic' 2 = 'Black, Non-Hispanic' 3 = 'Hispanic' 4 = Other or'2+ Races, Non-Hispanic'
CGEV100	**Have you smoked at least 100 cigarettes in your entire life? One hundred cigarettes is equal to 5 packs.**	0 = 'No' 1 = 'Yes'
CGNOW	**Do you now smoke cigarettes every day, some days, or not at all?**	0 = 'Not at all' 1 = 'Some days' 2 = 'Every day
ECEVER	**Have you ever used electronic vapor products, even one or two times?**	0 = 'No' 1 = 'Yes'
ECNOW	**Do you now use electronic vapor products every day, some days, rarely, or not at all?**	0 = 'Not at all' 1 = 'Rarely' 2 = 'Some days' 3 = 'Every day'
TCEVER	**Have you ever smoked traditional cigars, even one or two puffs?**	0 = 'No' 1 = 'Yes'
TCNOW	**Do you now smoke traditional cigars every day, some days, rarely, or not at all?**	0 = 'Not at all' 1 = 'Rarely' 2 = 'Some days' 3 = 'Every day'

LCEVER	**Have you ever smoked little cigars, cigarillos, or filtered cigars, even one or two puffs?**	0 = 'No' 1 = 'Yes’
LCNOW	**Do you now use little cigars, cigarillos, or filtered cigars every day, some days, rarely, or not at all?**	0 = 'Not at all' 1 = 'Rarely' 2 = 'Some days' 3 = 'Every day'
HKEVER	**Have you ever used hookahs, even one or two puffs?**	0 = 'No' 1 = 'Yes’
HKNOW	**Do you now use hookahs every day, some days, rarely, or not at all?**	0 = 'Not at all' 1 = 'Rarely' 2 = 'Some days' 3 = 'Every day'
FAMILY	**Calculated variable, combining variables related to how many children in the home in specific age ranges (PPT01, PPT25, PPT612, PPT1317) to reflect whether or not there is at least 1 minor child in the home.**	0 = 'No' 1 = 'Yes’
COMBUST	**Calculated variable to reflect current use of at least 1 combusted tobacco product (DOV_Smoker, TCEVER, TCNOW, LCEVER, LCNOW, HKEVER, HKNOW)**	0 = 'No' 1 = 'Yes’
VAPER	**Computed variable to reflect current use of vaporized tobacco product using electronic nicotine delivery system (ECEVER, ECNOW)**	0 = 'No' 1 = 'Yes’
NCUSE30	**In the past 30 days, have you used any of the following: chewing tobacco, dip or snuff, snus, or dissolvable tobacco?**	0 = 'No' 1 = 'Yes’
TOBPROD	**Computed variable to reflect current use of a combusted, vaporized and/or non-combusted tobacco product**	0 = 'No tobacco products currently used' 1 = '1 tobacco product currently used' 2 = '2 or more tobacco products currently used'

Appendix 2, Survey instrument developed in Qualtrics, administered on MTurk April 3-4, 2018 for Study 2 and Study 3

P-CRAINS Survey Instrument, revised 03/07/2018

Start of Block: Informed Consent

IC_00 Thank you for your interest in our study. We begin by asking for your agreement to participate, followed by several questions to determine if you qualify for participation.

IC_01 **Georgia State University School of Public Health Informed Consent**

Title:	Adults' perceptions of risks associated with children ingesting nicotine e-liquids
Principal Investigator:	Terry F. Pechacek, Ph.D.
Student Principle Investigator:	Catherine B. Kemp, BSN, MHA, Ph.D. Candidate
Co-Investigator:	Claire A. Spears, Ph.D.
Sponsor:	National Institutes of Health (NIH), Food and Drug Administration (FDA)

I. Purpose: We invite you to take part in a research study, led by Catherine Kemp, a Ph.D. candidate in the School of Public Health at Georgia State University, and her academic adviser, Dr. Terry Pechacek. We are doing this study to understand more about what adults think and know about children being exposed to the nicotine liquids used in electronic vaping devices like e-cigarettes. We would also like to learn more about how these materials are used and stored in people's houses. We are asking adults 18 years old and older who have at least one child (under 18 years old) living in their home and either: use electronic cigarettes or electronic vaping devices, live in a home with someone who uses electronic cigarettes or electronic vaping devices, or live in a home where no-one uses electronic cigarettes or electronic vaping devices to take part in this study. The rest of this consent form we will call these devices as 'EVP' (which stands for "electronic vaping products") and the nicotine liquids used in them as 'e-liquids'. **Please read this whole form; it will tell you everything you need to think about before you decide to agree to be in the study or not**.

II. Procedures: First we will ask you some questions to make sure you are eligible. If you are not eligible, you will not be able to complete the survey and will not be paid for responding to the screening questions. If you are eligible, we will ask you about your opinions on the effects these liquids and devices might have on children who are exposed to them. For people who use EVPs or live in a house where another adult uses EVPs, we will also ask about how EVPs are used and stored in your home. We think that it will take about 15 minutes to complete the survey. To learn more about cutting back on or quitting tobacco product use, contact the National Tobacco Quit Line at 1-877-44U-QUIT (1-877-448-7848).

III. Risks: First, there are privacy risks to completing surveys online because data sent over the Internet may not be secure. To reduce this risk, we will not ask you for any information that could identify you personally and we will store your answers to questions on a secure server. Second, it is possible that you may feel uncomfortable answering some of the questions. You are welcome to skip any questions that you don't want to answer.

IV. Benefits: You may not benefit personally from taking part in this study. Overall, we hope to learn about your opinions and practices related to the handling and storage of EVPs to help the Food and Drug Administration and National Institutes of Health in developing policies to protect the public's health.

V. Compensation: You will complete the study using a computer over the Internet. Once you complete the survey, you will receive payment from MTurk worth $2.00. Please know that taking the survey is voluntary. You will still get your incentive even if you skip some questions, but you do have to go to the end of the survey to receive the $2.00 payment.

VI. Voluntary Participation and Withdrawal: Taking part in this research is voluntary. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or withdraw from the study at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VII. Confidentiality: We will keep the responses you provide private to the extent allowed by law. We are not asking for your name or other facts that could be used to identify you. The findings will be pooled and reported in group form. Only the study's Principal Investigator, Ms. Kemp, and project staff will have access to the answers you give, which will be stored in a locked folder on a firewall-protected computer that is on a secure server. Only the Principal Investigator and project staff will have access to these data. Study responses might be shared with those who make sure the study is done correctly (GSU Institutional Review Board, and the National Institutes of Health and the Food and Drug Administration, the study sponsors). We plan to share the results of the study with other researchers, in papers, and at conferences.

VIII. Contact Persons: Contact Catherine Kemp at (404) 413-1142 or ckemp9@student.gsu.edu if you have questions, concerns, or complaints about this study. You can also call if you think you have been harmed by the study. Call Susan Vogtner in the Georgia State University Office of Research Integrity at 404-413-3513 or svogtner1@gsu.edu if you want to talk to someone who is not part of the study team. You can talk about questions, concerns, give suggestions, or learn more about the study. You can also call Susan Vogtner if you have questions or concerns about your rights in this study.

IX. Copy of Consent Form to Participant: If you would like a copy of this consent form, please print it from this screen before going to the next screen. If you agree to participate in this research, please click the CONTINUE button.

○ CONTINUE, I have read the information above and I agree to participate in this study (1)

○ EXIT, I have read the information above and I DO NOT agree to participate in this study (2)

Skip To: End of Block If Georgia State University School of Public Health Informed Consent Title: Adults' perceptions... = CONTINUE, I have read the information above and I agree to participate in this study
Skip To: End of Survey If Georgia State University School of Public Health Informed Consent Title: Adults' perceptions... = EXIT, I have read the information above and I DO NOT agree to participate in this study

End of Block: Informed Consent

Start of Block: Screening Questions

SC_00 Screening/inclusion criteria

Page Break

SC_01 What is your age (in years) as of your last birthday?

Click to write Label 1

15 21 28 34 40 46 53 59 65 71 75

(1)

Skip To: EXCLUDED If What is your age (in years) as of your last birthday? <
Skip To: SC_02 If What is your age (in years) as of your last birthday? >=

SC_02 Using numbers, please enter the year you were born in the box below, using 4 digits.
For example, if you were born in 1988, enter 1988 in the box.

○ Year (YYYY) (1) _____

Skip To: EXCLUDED If Using numbers, please enter the year you were born in the box below, using 4 digits. For example... >= Year (YYYY)

Page Break

Sec.II EVP USE We'd like to ask about **electronic vapor products** (such as e-cigarettes, e-cigars, e-hookahs, e-pipes, vape pens, hookah pens, and personal vaporizers/mods), and the liquids used in them.
Electronic vapor products are battery-powered and usually contain e-liquid (that may or may not contain nicotine) that is heated into a vapor or mist and inhaled.

Some can be bought as one-time use, disposable products, while others are reusable with a rechargeable battery and a cartridge or refillable tank system.

For the remainder of this survey, we will refer to using the devices as 'vape' or 'vaping', and the liquids used in them as 'e-liquids'.
The picture below illustrates how these devices (left) and e-liquids (right) might appear. (Pictures taken from: http://www.photosforclass.com/search/vape)

Page Break

ECAWARE Have you ever seen or heard of any type of electronic vapor product, such as e-cigarettes, e-cigars, e-hookahs, e-pipes, vape pens, hookah pens or personal vaporizers/mods before this study?

○ Yes (1)

○ No (2)

Skip To: EXCLUDED If Have you ever seen or heard of any type of electronic vapor product, such as e-cigarettes, e-ciga... = No

Page Break

SC_03 Please read all options and choose the statement below that best describes use of electronic vapor products by adults who live in your home, including yourself.

- ☐ I have used electronic vapor products at least once in the past month. (1)
- ☐ Another adult who lives with me has used electronic vapor products at least once in the past month. (2)
- ☐ Both I and another adult who lives with me have used electronic vapor products at least once in the past month (3)
- ☐ I have used electronic vapor products in the past, but not in the past month. (4)
- ☐ Another adult who lives with me has used electronic vapor products in the past, but not in the past month. (5)
- ☐ Neither I nor any other adult who lives with me has ever used electronic vapor products. (6)

Skip To: EXCLUDED If Please read all options and choose the statement below that best describes use of electronic vapo... = I have used electronic vapor products in the past, but not in the past month.
Skip To: EXCLUDED If Please read all options and choose the statement below that best describes use of electronic vapo... = Another adult who lives with me has used electronic vapor products in the past, but not in the past month.

Page Break

Display This Question:
If Please read all options and choose the statement below that best describes use of electronic vapo... = I have used electronic vapor products at least once in the past month.
And Please read all options and choose the statement below that best describes use of electronic vapo... = Another adult who lives with me has used electronic vapor products at least once in the past month.
And Please read all options and choose the statement below that best describes use of electronic vapo... = Both I and another adult who lives with me have used electronic vapor products at least once in the past month

SC_ECFRQ30 On approximately how many of the past 30 days have electronic vapor products been used by you or another adult who lives in your home?

0 5 10 15 20 25 30

Days (1) 

Skip To: EXCLUDED If On approximately how many of the past 30 days have electronic vapor products been used by you or... = Days

SC-NIC Do the e-liquids that are vaped in electronic vapor products in your home usually contain nicotine?

- ○ Yes (1)
- ○ No (2)
- ○ I don't know (3)

Skip To: EXCLUDED If Do the e-liquids that are vaped in electronic vapor products in your home usually contain nicotine? = No

Page Break

SC_Child_01 How many children who are 6 years old or younger live in in your household, whether or not you are their parent or guardian?

▼ 0 (1) ... 10 or more (11)

Skip To: EXCLUDED If How many children who are 6 years old or younger live in in your household, whether or not you ar... = 0

SC_Child_02 Please indicate the age of the **youngest** child who lives in your household (whether or not you are their parent or guardian)

0 1 2 3 4 5 6 7 8 9 9 10 11 12 13 14 15 16 17

Age of youngest child in the home (1)

Skip To: End of Survey If Please indicate the age of the youngest child who lives in your household (whether or not you are... > Age of youngest child in the home

Display This Question:
If Please indicate the age of the youngest child who lives in your household (whether or not you are... [Age of youngest child in the home] <= 6

SC_Child_03 What is your relationship to the **youngest** child who lives in your home?

- Biological parent (1)
- Step-parent (2)
- Grandparent (3)
- Aunt or uncle (4)
- Sibling (5)
- Domestic partner of child's parent (not married) or primary caregiver (6)
- Roommate of child's parent or primary caregiver (7)
- Other (8)

Display This Question:
If What is your relationship to the youngest child who lives in your home? = Other

SC_Child_03a Briefly describe your relationship to the child(ren) living in your home

_____

Page Break

Display This Question:
If Please indicate the age of the youngest child who lives in your household (whether or not you are... [Age of youngest child in the home] > 1

SC_Child_04 Of how many of the children in your household are you the parent, step-parent, or guardian?

0 1 2 3 4 5 6 7 8 9 10

Child 1 (1)

Page Break

SC_GENDER What is your gender?

- Male (1)
- Female (2)

Page Break

SC_08 What is your racial/ethnic background?

▼ White, non-Hispanic (1) ... Other (5)

Display This Question:
If What is your racial/ethnic background? = Other

Q107 Briefly describe your racial/ethnic background.

_____

Page Break

SC_11 Including you, how many adults (people 18 years old or older) live in your household?

▼ 1 (1) ... 10 or more (10)

Page Break

SC_EDU What is the highest level of education you've completed as of today?

▼ Less than high school (1) ... Professional degree or Doctorate (6)

Page Break

SC_INC What is your household's average yearly (annual) income?

▼ Less than $25,000 (1) … Over $100,00 (4)

Page Break

SC_09 In what region of the country do you live?

▼ Northeast (CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT) (1) ... Puerto Rico, Guam, U.S. Virgin Islands, or other US territories (6)

Page Break

EXCLUDED Thank you for your interest in our study. We are looking for people with specific characteristics to include in the study. Based on the responses you've provided, you either do not meet these criteria or we already have the number of responses needed from people who have these characteristics.
Please click the "Exit" button below to exit the survey or close this window in your browser.

○ Exit (1)

Skip To: End of Survey If Thank you for your interest in our study. We are looking for people with specific characteristics... = Exit

End of Block: Screening Questions

Start of Block: Risk perceptions-children's exposure, (adapted from Garbutt study)

NEL_00 The next set of question are related to your knowledge and opinions of the risks to a child (6 years old or younger) of different kinds of exposure to nicotine e-liquids used in EVPs, such as e-cigarettes, e-cigars, e-hookahs, e-pipes, vape pens, hookah pens and personal vaporizers/mods.

For these questions **"vapor" refers to the steam from an EVP**, and **"e-liquids" refers to vaping liquids that contain nicotine**.

Page Break

NEL_02 How dangerous do you think skin contact with one or two drops of e-liquid is for a child (6 years old or younger)?

○ Very dangerous (1)

○ Moderately dangerous (2)

○ Minimally dangerous (3)

○ Not dangerous at all (4)

○ I don't know (5)

Page Break

NEL_03 How dangerous do you think skin contact with a teaspoon or more of e-liquid is for a child (6 years old or younger)?

- Very dangerous (1)
- Moderately dangerous (2)
- Minimally dangerous (3)
- Not dangerous at all (4)
- I don't know (5)

Page Break

NEL_04 How dangerous do you think it would be for a child (6 years old or younger) if one or two drops of e-liquid got on their lips, in their nose, or in their eyes?

- Very dangerous (1)
- Moderately dangerous (2)
- Minimally dangerous (3)
- Not dangerous at all (4)
- I don't know (5)

Page Break

NEL_05
How dangerous do you think it would be for a child (6 years old or younger) if a teaspoon or more of e-liquid got on their lips, in their nose, or in their eyes?

- Very dangerous (1)
- Moderately dangerous (2)
- Minimally dangerous (3)
- Not dangerous at all (4)
- I don't know (5)

Page Break

NEL_06 How dangerous do you think it would be for a child (6 years old or younger) if they swallowed one or two drops of e-liquid?

- Very dangerous (1)
- Moderately dangerous (2)
- Minimally dangerous (3)
- Not dangerous at all (4)
- I don't know (5)

Page Break

NEL_07 How dangerous do you it would be for a child (6 years old or younger) if they swallowed a teaspoonful or more of e-liquid?

- Very dangerous (1)
- Moderately dangerous (2)
- Minimally dangerous (3)
- Not dangerous at all (4)
- I don't know (5)

Page Break

NEL_08 How dangerous do you think it is for a child (6 years old or younger) to inhale the vapor directly from an EVP?

- Very dangerous (1)
- Moderately dangerous (2)
- Minimally dangerous (3)
- Not dangerous at all (4)
- I don't know (5)

Page Break

NEL_09 How dangerous do you think is for a child (6 years old or younger) to inhale the second-hand vapor from another person using an EVP?

- Very dangerous (1)
- Moderately dangerous (2)
- Minimally dangerous (3)
- Not dangerous at all (4)
- I don't know (5)

Page Break

NEL_10 How dangerous do you think is for a child (6 years old or younger) to inhale smoke directly from a cigarette?

- Very dangerous (1)
- Moderately dangerous (2)
- Minimally dangerous (3)
- Not dangerous at all (4)
- I don't know (5)

Page Break

NEL_11 How dangerous do you think is for a child (6 years old or younger) to inhale the second-hand smoke from another person smoking a cigarette?

- Very dangerous (1)
- Moderately dangerous (2)
- Minimally dangerous (3)
- Not dangerous at all (4)
- I don't know (5)

Page Break

NEL_12 Compared to inhaling smoke directly from a cigarette, how dangerous do you think is for a child (6 years old or younger) to inhale the vapor directly from an EVP?

- Much more dangerous (1)
- Somewhat more dangerous (2)
- About the same (3)
- Somewhat less dangerous (4)
- Not dangerous at all (5)
- I don't know (6)

Page Break

NEL_13 Compared to inhaling second-hand smoke from a cigarette, how dangerous do you think is for a child (6 years old or younger) to inhale the second-hand vapor from another person using an EVP?

- Much more dangerous (1)
- Somewhat more dangerous (2)
- About the same (3)
- Somewhat less dangerous (4)
- Not dangerous at all (5)
- I don't know (6)

Page Break

Q133 How much is the following statement true for you?

I am always courteous, even to people who are disagreeable.

- Definitely true (1)
- Mostly true (2)
- I don't know (3)
- Mostly false (4)

- Definitely false (5)

Page Break

Q134 How much is the following statement true for you?

There have been occasions when I took advantage of someone.

- Definitely true (1)
- Mostly true (2)
- I don't know (3)
- Mostly false (4)
- Definitely false (5)

Page Break

Q135 How much is the following statement true for you?

I sometimes try to get even rather than forgive and forget.

- Definitely true (1)
- Mostly true (2)
- I don't know (3)
- Mostly false (4)
- Definitely false (5)

Q136 How much is the following statement true for you?

I sometimes feel resentful when I don't get my way.

- Definitely true (1)
- Mostly true (2)
- I don't know (3)
- Mostly false (4)
- Definitely false (5)

Q137 How much is the following statement true for you?

No matter who I'm talking to, I'm always a good listener.

- Definitely true (1)
- Mostly true (2)

- I don't know (3)
- Mostly false (4)
- Definitely false (5)

End of Block: Risk perceptions-children's exposure, (adapted from Garbutt study)

Start of Block: EVP Risk Perceptions

VAPE_00 Please indicate how strongly you agree or disagree with the following statements

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongl disagre (5)
Vaping is addictive. (1)					
Compared to smoking cigarettes, vaping is less addictive. (2)					
Vaping is safe for the health of adults who vape. (3)					
Being exposed to someone else's vaping is safe for adults. (4)					
Being exposed to someone else's vaping is safe for children. (5)					
Seeing adults vaping could influence a child to start vaping. (6)					

Page Break

End of Block: EVP Risk Perceptions

Start of Block: Actual Nicotine Exposures

Display This Question:
If Please read all options and choose the statement below that best describes use of electronic vapo... != Neither I nor any other adult who lives with me has ever used electronic vapor products.

NEL_15_X
Now we'd like to ask you about how nicotine containing e-liquids and electronic vapor products are handled and stored in your home.

The e-liquids used in electronic vaporizer products in my home have child-proof caps. (1)	Always	Sometimes	Never	I don't know
The e-liquids used in electronic vaporizer products in my home are stored in a designated place. (2)	Always	Sometimes	Never	I don't know
The e-liquid used in electronic vaporizer products in my home are kept out of reach of children. (3)	Always	Sometimes	Never	I don't know

We enforce rules in our house regarding the handling of the e-liquid used in electronic vaporizer products in my home. (4)	Always	Sometimes	Never	I don't know
We enforce rules in our house regarding the storage of the e-liquid used in electronic vaporizer products in my home. (5)	Always	Sometimes	Never	I don't know
The children who live with me are told they should not handle the e-liquid used in electronic vaporizer products in my home. (6)	Always	Sometimes	Never	I don't know
The children who live with me see adults handling electronic vaping products in my home. (7)	Always	Sometimes	Never	I don't know
The children who live with me are allowed to handle electronic vaping products in my home. (8)	Always	Sometimes	Never	I don't know
The children who live with me see adults using electronic vaping products in my home. (9)	Always	Sometimes	Never	I don't know
Bottles of nicotine e-liquids are left uncapped. (10)	Always	Sometimes	Never	I don't know
Nicotine e-liquids are mixed in my home. (11)	Always	Sometimes	Never	I don't know
The nicotine e-liquid packaging is brightly colored. (12)	Always	Sometimes	Never	I don't know
The nicotine e-liquid packaging has pictures on it. (13)	Always	Sometimes	Never	I don't know
The bottle cap is replaced with a pouring tip. (14)	Always	Sometimes	Never	I don't know
Nicotine e-liquid is stored in a designated place out-of-reach of children. (15)	Always	Sometimes	Never	I don't know

End of Block: Actual Nicotine Exposures

Start of Block: NicExB_00

NicExA_01-4 The next set of questions are regarding child(ren) living in your home actually being exposed to nicotine e-liquids.

	Select one		
	Yes (1)	No (2)	I don't know (3)
A child in my home has touched or held a nicotine e-liquid container. (1)			
A child in my home has ingested nicotine e-liquid. (2)			

An adult has sought information from a poison control website, telephone helpline, and/or healthcare professional because a child in my home was exposed to nicotine e-liquid. (3)	○	○	○
A child in my home has had medical attention due to nicotine e-liquid exposure. (4)	○	○	○

Page Break

NicExA_05 If a child(ren) living in your home was actually exposed to nicotine e-liquids, what would be your ***first*** response?

- ○ Nothing (1)
- ○ Call 911 (2)
- ○ Call the local Poison Control Hotline (3)
- ○ Search the Internet for information on what to do (4)
- ○ Watch the child for symptoms of toxicity or illness (5)
- ○ Call the child's primary healthcare provider (6)
- ○ Take the child to their doctor's office (7)
- ○ Take the child to a walk-in clinic or emergency room (8)

Page Break

End of Block: NicExB_00